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Sampling and Analysis Plan for Waste Disposition of KE Basin Wall and Floor Surface Removal Residue

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Sampling and Analysis Plan for Waste Disposition of KE Basins Wall and Floor Surface Removal Residue

Prepared for the U S. Department of Energy
Assistant Secretary for Environmental Management

Fluor Hanford
P.O. Box 1000
Richland, Washington

Contractor for the U S Department of Energy
Richland Operations Office under Contract DE-AC06-96RL13200

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December 2003

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A-7320-005 (10/97)

CONTENTS

APPENDIX

FIGURES

TABLES

TERMS

AEA	alpha energy analysis
AJHA	Automated Job Hazards Analysis
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
BHI	Bechtel Hanford, Inc
CFR	*Code of Federal Regulations*
CH2M HILL	CH2M HILL Hanford Group, Inc
CMP	Chemical Management Program
COC	contaminant of concern
COPC	contaminant of potential concern
DFSNW	Duratek Federal Services Northwest
DOE	U S. Department of Energy
DQO	data quality objective
DR	decision rule
DS	decision statement
EPA	U.S Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
FH	Fluor Hanford, Inc.
GEA	gamma energy analysis
HASP	*K-Basins Interim Remedial Action Health and Safety Plan*
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
HGET	Hanford General Employee Training
ICP/MS	inductively coupled plasma/mass spectrometry
LCS	laboratory control sample
LLBG	Low-Level Burial Ground
LSC	liquid scintillation counting
MDL	minimum detection limit
NDA	nondestructive analysis
NIST	National Institute of Standards
NRC	U.S Nuclear Regulatory Commission
PCB	polychlorinated biphenyl
PHMC	Project Hanford Management Contract
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
QC	quality control
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SAR	safety analysis report
SNF	spent nuclear fuel
SOP	standard operating procedure
TC	toxic characteristic
TSCA	*Toxic Substances Control Act of 1976*

WAC	waste acceptance criteria
WS	waste stream
WTEC	West Tech International, Inc.

1.0 INTRODUCTION

1.1 BACKGROUND

To lower the radiation dose produced by the K East Basin once the water is drained, removal of the basin concrete wall and floor surfaces is planned. The uncoated concrete surface is known to have been penetrated by gamma-radiation-producing radionuclides, primarily Cs-137, to the extent that surface removal is necessary. The removed concrete surface residue will be collected and packaged for eventual disposal The residue will contain radionuclides and will be managed for polychlorinated biphenyls (PCB) under the *Toxic Substances Control Act of 1976* (TSCA) applicable or relevant and appropriate requirements (ARAR). The source of radioactive contamination is the spent fuel stored in the basin, primarily N Reactor fuel. The waste residues must be characterized and designated to facilitate proper management The residues will be PCB remediation waste that is either transuranic (TRU[1]) (U S Nuclear Regulatory Commission [NRC] greater than Class C) or low-level radioactive

1.2 DATA QUALITY OBJECTIVES

The data quality objectives (DQO) applicable to this waste are provided in Appendix A. The list of constituents of concern (COC) determined by the DQOs are provided in Table 1-1

Table 1-1 Final List of Contaminants of Concern

WS #	COCs
1	Th-232, Pa-231, U-232, U-233, U-234, U-235, U-236, Np-237, U-238, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Am-242m, Pu-242, Am-243, Cm-242, Cm-243, Cm-244, Sm-151, Eu-152, Eu-154, Eu-155, H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Se-79, Sr-90, Mo-93, Zr-93, Nb-94, Tc-99, Pd-107, Cd-113m, Sn-121m, Te-123, Sb-125, Sn-126, I-129, Cs-134, Cs-135, Cs-137, Pm-147
	Polychlorinated biphenyl
	Free liquid

COC = Contaminant of concern
WS = waste stream

1.2.1 Statement of Problem

To package waste consisting of the removed surface of the concrete K East Basin walls and floor for disposal to the Environmental Restoration Disposal Facility (ERDF), data regarding the

[1]Waste materials contaminated with 100 nano Curies per gram of transuranic radionucides having half-lives longer than 5 years

radionuclides concentrations, surface radiation dose to activity concentrations, and physical characteristics of the waste are needed.

A team was assembled and a workshop set up to determine the DQOs and put together this sampling analysis plan (SAP). Table 1-2 identifies the DQO workshop team members. Table 1-3 identifies the key decision makers.

Table 1-2. Data Quality Objectives and Sampling Analysis Plan Team Members.

Name	Company/Organization	Position or Area of Expertise
Dave Watson	FH/K Basins Project	Regulatory Support
Glen Chronister	FH/ K Basins Project	Project Engineer
Rod Jochen	FH/K Basins Project	Sample/Characterization Specialist
Dave Bechtold	CH2MHILL/222-S Laboratory	Sample Analysis and Chemistry
Kathy Powell	CH2MHILL/222-S Laboratory	Sample Analysis
Rich Lipinski	BHI/Waste Management	Waste Management
Ryan Ollero	BHI/Waste Management	Waste Management
Jeff Westcott	FH/Waste Management	Task Lead and Waste Management
John Woodbury	DFSNW/Transportation	Transportation Specialist
Bruce Makenas	FH/K Basins Project	Characterization Specialist
Jim Zimmerman	FH/K Basin Project	Waste Management
Noel Hinojosa	FH/K Basin Project	Waste Management
Carol Rodriguez	WTEC	

BHI = Bechtel Hanford, Inc.
CH2M HILL = CH2M HILL Hanford Group, Inc.
DFSNW = Duratek Federal Services Northwest.
FH = Fluor Hanford, Inc.
WTEC = West Tech International, Inc..

Table 1-3. Key Decision Makers.

Name	Organization
Larry Earley	U.S. Department of Energy, Richland Operations Office
Larry Gadbois	U.S. Environmental Protection Agency

1.2.2 Identify the Decisions

The DQO determined that the waste will not be designated as dangerous waste and will be managed for PCB in accordance with the TSCA ARAR, so these issues will not be considered further in the document. See the DQO provided in Appendix A for an explanation of the decision rationale.

The data, both analytical and equipment performance, obtained as directed by this document will be used to characterize the waste for disposal and evaluate the waste shipping package The shipping package is expected to require the use of shielding

Table 1-4 Decision Statements for Designation of K East Basin Removed-Surface-Generated Waste.

DS #1 – Determine if the waste does exceed the ERDF radiological or cannot be treated to meet ERDF waste acceptance criteria then the waste must be stored or disposed of at another candidate facility (e g , CWC/LLBG) OR if the material does not exceed the ERDF radiological or can be treated to meet ERDF waste acceptance criteria then waste is disposed of at the ERDF Water will be sent to the ETF
DS #2 - Determine if the waste package will have to be engineered to comply with shipment requirements OR, if the waste package does not require engineering to ship waste

CWC = Central Waste Complex
DS = Decision statement
ERDF = Environmental Restoration Disposal Facility
LLBG = Low-Level Burial Ground
ETF = Effluent Treatment Facility

1.2.3 Identify Inputs to the Decisions

The data inputs needed to resolve each of the decisions statements have been identified, along with analytical performance requirements to support the data. See the DQO (Appendix A) for the logic behind the selection of inputs, analytical methods and field techniques, and tables that present these information needs Process knowledge will be used to designate waste for toxic characteristic (TC) metals and PCBs, no analyses will be conducted to support decisions related to these contaminants of potential concern (COPC)

Evaluation of waste process knowledge led to the conclusion that the waste will not be designated as a dangerous waste Listed constituents were not added to the K East Basin. Concrete itself does not exhibit characteristics of dangerous waste. Chemicals, such as algaecides, and metals added to or in the basin are dilute and have no affinity for concrete.

The ERDF can dispose of PCB waste, so an estimate of the PCB content of the waste is all that is necessary to facilitate disposal at the ERDF. The PCB has no affinity for concrete, so the concentration of PCB in the waste would be no higher than the maximum PCB concentration in the basin sludge The concentration of PCB in the waste is assigned the maximum concentration of sludge.

The floor or basin water could have a small quantity of sludge remaining at the time of surface removal If so, an estimate of the sludge quantity is needed to determine the sludge contribution to the waste characterization

1.2.4 Define the Study Boundaries

The study boundaries identify the spatial and temporal boundaries of the action under investigation, as well as practical constraints that must be taken into consideration The action that is the subject of this document is the removal of the underwater concrete wall and floor surfaces from the K East Basin. It is expected that a high-pressure water removal method called hydrolasing will be employed This document extends to the removed concrete surface, including sludge if any remains, and the material on which it is collected, which is expected to be an arrangement of strainers and filters, as well as material that the removed surface could contaminate, such as pipe and equipment

Data being collected will include both field measurements of radiation dose and analysis of samples of K East Basin wall. Radiation dose measurements will be collected on the concrete surface as it is being removed Samples will be collected for analysis on a selected portion of the wall on which the concrete surface removal technology is being demonstrated The samples of cemetitious residue will be collected from one point on the wall during each pass removing a surface layer Four passes are planned so four samples will be taken The safety basis limits the location where the demonstration can take place and the samples are collected. Also, the sampling apparatus itself limits sample collection to one sample on each pass. Samples collected at one point on the wall will adequately represent the whole wall and floor for the purpose of estimating the radionuclide distribution in a waste container. The DQO (Appendix A) provides further detail on these limitations and the rationale for applying these data to the entire basin wall and floor

Field measurements of radiation dose on the exterior of the waste package will be collected. Either the dose measurement of the concrete surface as the surface is being removed or the dose measurement of the exterior of the waste package will be used to estimate Cs-137 content of the waste package The total package radionuclide inventory is determined by using the radionuclide distribution to scale nuclides to Cs-137 content of the package estimated from dose information.

1.2.5 Decision Rules

The information developed in the previous steps of the DQO (Appendix A) are combined with the parameter of interest and an action level to provide a concise description of what action will be taken based on the results of data collected. Table 1-5 in the DQO lists the final action level for each decision statement and COC, this information has been incorporated into analytical performance requirements later in this document. Table 1-5 lists the decision rules that apply to the designation of the K East Basin removed surface material.

Table 1-5. Decision Rules for Designation of K East Basin Removed-Surface-Generated Waste.

DR #1 – If the waste <u>does exceed</u> the ERDF radiological waste acceptance criteria and cannot be treated, the waste must be stored or disposed at the Hanford Site CWC or LLBG If the liquid content of the waste does not comply with the ERDF waste acceptance criteria, the liquid must be removed to comply with requirements before the waste is shipped to the ERDF or CWC/LLBG Liquid will be sent to the ETF
If the waste <u>does not exceed</u> the ERDF radiological or has been treated to meet ERDF waste acceptance criteria, it will be disposed of at the ERDF

Table 1-5 Decision Rules for Designation of K East Basin Removed-Surface-Generated Waste.

DR #2- If the waste package does not comply with shipment requirements, a new or engineered package will have to be developed for transport to the destination facility
If the waste package complies with shipment requirements, it will be used to ship waste to the destination facility

CWC = Central Waste Complex
DR = Decision rule
ERDF = Environmental Restoration Disposal Facility
LLBG = Low-Level Burial Ground
ETF = Effluent Treatment Facility

1.2.6 Limits on Decision Error

This section of a DQO generally is used to establish the parameters for a statistically based sample design. A statistically based approach will not be used because of the spatial uniformity of basin waster quality to which the bare concrete was exposed See the DQO (Appendix A) for additional details.

The waste is presumed to contain levels of PCB commensurate with the maximum PCB loading in sludge and to contain free liquids until shown otherwise

The radionuclide inventory of each waste package will be estimated using field measurements of radiation dose to determine the Cs-137 inventory, then ratios to Cs-137 will be used to determine the complete package radionuclide inventory Radiation-dose-to-Cs-137 inventory curves will be developed as necessary based on modeling with validation from measurements collected The radiation-dose-to-Cs-137 inventory conversion will be based on dose rates on either the concrete surface or waste containers

A water sample will be collected at the discharge of the concrete surface removal water cleanup system. The sample will be analyzed to identify excessive basin water contamination that could affect the waste characterization

2.0 QUALITY ASSURANCE PROJECT PLAN

This document is written in accordance with the applicable requirements of EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans*.

2.1 PROJECT MANAGEMENT

This section identifies the individuals or organizations participating in the project and discusses their specific roles and responsibilities. This section also discusses quality objectives for measurement data and special training requirements for staff performing the work

2.1.1 Project Organization

Figure 2-1 presents the organization chart for sampling/analysis and waste management interfaces to the ERDF

2.1.2 Roles and Responsibilities

This section identifies the responsibilities of the organizations supporting K Basin concrete surface removal and disposal activities that collect, analyze, survey, or assess results of data for waste disposal

K Basin Operations Support Sample Management Representative

The K Basin operations support sample management representative has the following responsibilities:

- Maintain operating procedures as custodian, and revise procedures that cover sample collection, chain of custody, packaging, and shipping.
- Maintain sample analysis records in a 2-hour-rated-fire-resistant file cabinet.
- Receive data packages.
- Perform or contract data review
- Maintain copies of radiological survey records and assemble into files to support waste characterization and designation

Nuclear Process Operators

The nuclear process operators have the following responsibilities.

- Perform sampling
- Document sampling activities in a controlled logbook.

- Initiate chain of custody
- Package and ship samples to the 222-S Laboratory or an offsite laboratory.

Laboratories (i.e., 222-S Laboratory, Waste Sampling and Characterization Facility, pre-selected offsite contract laboratories)

The laboratories have the following responsibilities:

- Receive samples and initiate internal chain of custody.

- Perform specified radiological or nonradiological analyses.

- Provide specified data package to the operations support sample management representative.

K Basin Operations Support Manager (or Designee)

The K Basin operations support manager has the following responsibilities

- Oversee sample management program.
- Authorize new radionuclide scaling factors to be applied to waste as needed.
- Obtain additional analytical services as needed.

Radiological Control Organization

The Radiological Control Organization has the following responsibilities.

- Conduct specified surveys.
- Provide radiation dose rate data for sample collection, packaging, and shipment
- Provide the radiological work permit.

Waste Management

The Waste Management Organization has the following responsibilities:

- Designate waste based on radiation dose survey and/or laboratory results to calculate radionuclide content

- Ship waste or sample for analysis.

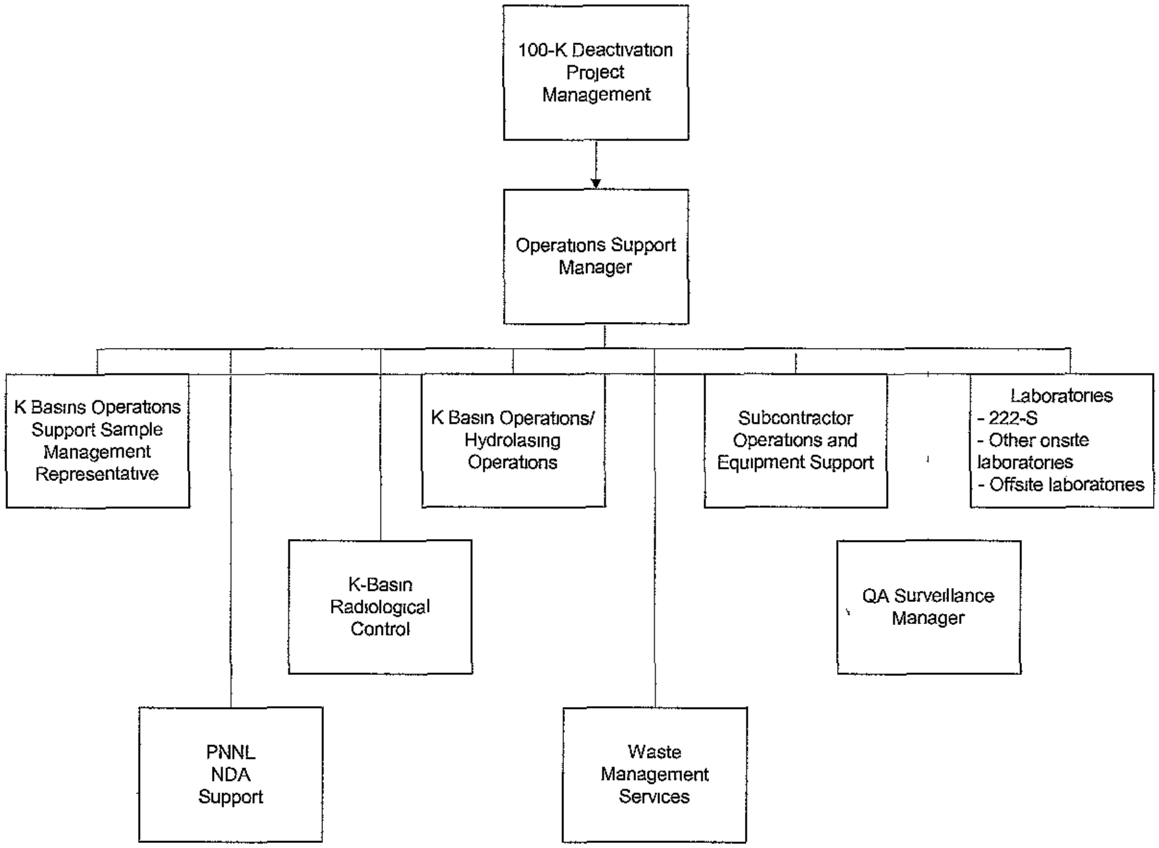
- Review data used to designate waste

Quality Assurance Organization

The Quality Assurance Organization has the following responsibilities:

- Fluor Hanford, Inc (FH), Quality Assurance (QA) has the option to conduct random surveillance to verify compliance with the implementation of this sample and analysis plan.

Figure 2-1. Sampling/Analysis and Waste Management Organization Chart.



2.1.3 Special Training Requirements and Certification

Hazards associated with radiation and radiological contamination are well characterized in the K Basins HNF-5173, *PHMC Radiological Control Manual*, addresses worker training requirements, visitor training and escort requirements, dosimetry monitoring, posting, and required radiological surveillance. The specific training required by Title 29, *Code of Federal Regulations* (CFR), Part 1910.120, "Occupational Safety and Health Standards," is implemented through HNF-5173. Training requirements for this project are discussed in HNF-4747, *K-Basins Interim Remedial Action Health and Safety Plan* (HASP), Chapter 7. Project-specific training requirements and references are discussed in the following paragraphs.

If a worker may have a reasonable possibility of exposure to hazardous chemicals while performing a specific remediation task in the K Basins, the Facility Operations Manager will ensure that the worker has the appropriate level of training, in accordance with 29 CFR 1910.120, before the work is performed.

HNF-5173, *PHMC Radiological Control Manual*, defines radiological training requirements for various circumstances applicable to entry into the K Basins Training requirements in this procedure apply to all individuals who are required to have access to the K Basins.

Job-specific training requirements for SNF Project personnel are outlined in Procedure TN 8-001-13, *General Training Administration.* This procedure covers facility orientation training, Hanford General Employee Training (HGET), the facility emergency plan, SNF Project orientation, initial and continuing training, on-the-job training, and required reading and drills The training requirements for each employee are determined using a graded approach and are documented in the appropriate training matrix.

All visitors, general employees, or members of the public, will have training or instruction before entry to the K Basins in accordance with the requirements of HNF-5173.

2.1.4 Quality Objectives and Criteria for Measurement Data

The QA objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality. Data quality typically is assessed by representativeness, comparability, accuracy, precision, and completeness. These parameters are described in the following paragraphs. The applicable quality control (QC) guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. A summary of COCs for each concrete residue is provided in Table 1-4 of the DQO (Appendix A) The analytical methods, laboratory detection limits, and sample size for COCs that will be measured are presented in Section 2 2 5. Quality control parameters of accuracy and precision that are to be applied to solids characterization samples are presented in Tables 2-1 and 2-2 The liquid samples counting error will be managed to maintain less than 25 percent uncertainty at a 95 percent confidence. The nomenclature used to describe quality parameters is contained in the following discussion

Representativeness. Representativeness is a measure of how closely analytical results reflect the concentration of radiological constituents distributed in the sample matrix Sampling plan design, sampling techniques, and sample-handling protocols (e g , storage, preservation, and transportation) have been developed and are discussed in subsequent sections of this document. The documentation will establish that protocols have been followed and sample identification and integrity is ensured.

Comparability Comparability expresses the confidence with which one data set can be compared to another. Data comparability will be maintained by using standard documented procedures, consistent methods, and consistent units. Fixed laboratory methods for analytes and target detection limits are listed in Tables 2-3 and 2-4 Actual detection limits will depend on the sample matrix, constituent radionuclides, and sample quantity available, and will be reported as defined for the specific samples. Detection limits are functions of the analytical method used to provide the data and the quantity of sample available for analyses.

Accuracy Accuracy is an assessment of the closeness of the measured value to the true value Accuracy of analytical results is assessed using either laboratory control samples (LCS) or using matrix spikes A matrix spike is the addition of a known amount of the analyte to the sample matrix being analyzed. The matrix spike percent recovery provides an estimate of the accuracy of the method for that matrix and indicates any matrix interferences to the method The LCS is a material, usually a simple aqueous solution that contains a known amount of the analyte of interest, that is analyzed using the same method as the sample The percent recovery for the LCS demonstrates that the method is working properly and gives an estimate of the method's accuracy Many radiochemical methods use tracers or carriers whose recoveries are used to correct the analytical results for method chemical separation losses. Matrix spikes are not used for these methods. For radiochemical methods, spikes (also tracers and carriers) are not added during the sample dissolution stages, but are added at the analyte separation stage. For inductively coupled plasma/mass spectrometry (ICP/MS), calibrations and spikes are not performed for all isotopes Counting equipment calibrations are verified by routine checks at a frequency defined in the QA plan and appropriate procedures. The ICP/mass spectrometer is calibrated for each batch of samples and the calibration is verified before analyses are initiated and after so many samples have been analyzed in accordance with the procedure. Table 2-1 lists the accuracy targets for radionuclide measurements.

Precision. Precision is a measure of the data spread when more than one measurement has been taken on the same sample Precision can be expressed as the relative percent difference for duplicate measurements. Precision targets for fixed laboratory analyses are listed in Table 2-1.

Completeness Completeness is a comparison of the amount of valid data obtained to the valid data required from the analytical measurement process and the complete implementation of defined field procedures The completeness objective for this SAP is set at 90 percent Completeness will be assessed on an analyte-specific basis If the completeness objective is not met, additional samples will be collected and analyzed or additional measurements will be taken

Table 2-1. Target Accuracy and Precision of Laboratory Solids Analysis Methods [1]

Matrix	Accuracy for Radionuclides (Percent Recovery)[2]	Precision for Radionuclides (Relative Percent Difference)[3]
Solids	50 – 150	± 50

[1]Accuracy and precision are based on published analytical methods for waste analyses (see Tables 2-3 and 2-4)

[2]Percent recovery = ([amount measured in spiked sample – amount in unspiked sample]/spike added)*100

[3]Relative percent difference = ([result 1 – result 2]/average result)*100

Table 2-2 Field Instrument Performance Requirements

Analyte	Analytical Method	Accuracy Requirement	Precision Requirement
Dose rate	Portable NaI detector, Bicron, microrem meter, or ion chamber	[1]	[1]
	Ludlum 133-7 radiation detector	[1]	[1]

[1]In accordance with manufacturer specifications

2.1.5 Documentation and Records

Field documentation will be kept in accordance with HNF-PRO-10588, *Records Management Process*

2.2 K EAST BASIN SAMPLING AND ANALYSIS TO ESTABLISH RADIONUCLIDE DISTRIBUTIONS

A nonstatistical sample collection will be performed as part of a concrete surface removal technology demonstration in the K East Basin. An approximately 9 3 square meters (100 square feet) section of wall has been selected to demonstrate the surface removal technology called hydrolasing The DQO [Appendix A] describes the demonstration location in the basin The solid samples will be collected from a location within the demonstration area where a higher radiation dose is identified A sample will be collected from each layer of surface being removed. It is expected that four layers will be removed. At the time of sample collection during the demonstration, the basin water quality (e g , turbidity) will be within normal operating ranges

A water sample will be collected on the discharge of the concrete surface removal water cleanup system The purpose of the sample is to identify excessive basin water contamination that could affect the waste characterization.

2.2.1 Sample Requirements

The samples of solid will be collected for analysis in accordance with work package 1K-03-01361, *Demonstration of Hydrolasing at 105K East (Hot Demo)*. First, the location for sample collection will be identified by running a radiation dose meter across the wall surface of the demonstration area The samples of solid will be collected at the location where the higher radiation dose rates are measured at the start of the demonstration As the demonstration proceeds, when the apparatus is at the sample location, the residue removed from the wall will be diverted into the sample collection filter until enough sample is collected Figure 2-2 is a schematic of the demonstration apparatus with the sample collection system

As part of the demonstration, the amount (i.e , depth) of concrete removed will be determined for each pass across the concrete surface. The aggregate (rock) part of the concrete surface removed will not be collected as part of the solid sample because it is not expected to contain significant quantities of the COCs. As part of the demonstration, the amount of aggregate and cementitious material per depth of surface removed will be estimated to support determining waste loading in waste containers

A water sample from the discharge of the surface removal water cleanup system will be collected during the technology demonstration. A water sample also will be collected during full-scale surface removal operation at least once a week

2.2.2 Sample Handling and Custody Requirements

Sample-handling, shipping, and chain-of-custody activities will be performed in accordance with Work Package 1K-03-01361 for solids samples and procedures OP-43-015, *Collect Special Water Samples from Routine and Nonroutine Locations*, and OP-43-005E, *Collect Routine Water Samples at 105-KE (Weekly)*, or OP-43-010E, *Collect Center of Basin Air Permit Water Sample*, for liquid samples

The solid sample material is expected to exhibit significant radiation dose. The solid sample will be handled, shipped, and stored to reduce personnel exposure to as low as reasonably achievable (ALARA).

2.2.3 Sample Preservation, Containers, and Holding Times

No preservatives need to be added to samples of solid, nor is refrigeration necessary for these samples The solid-sample containers with integral filter may be plastic, glass, or stainless steel and must be clean of any radiological contamination before use Sample collection containers and filters will not be used then cleaned for reuse.

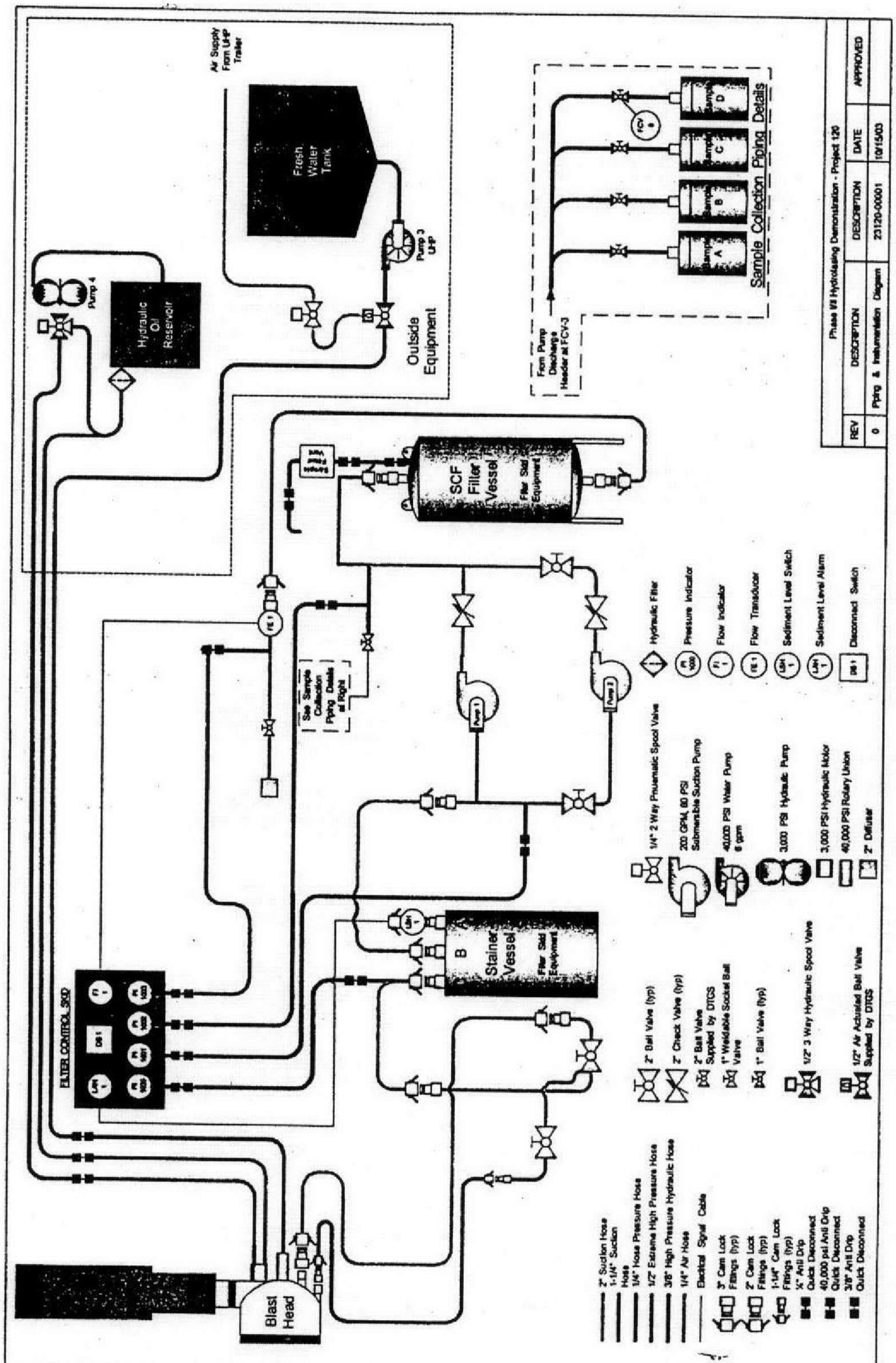
Samples of water require acidification to pH of 2 for preservation for gamma energy analysis (GEA). No preservation is needed if using the 1706KE Counting Facility for Cs-137, total alpha and/or total beta. Containers are specified in Sampling Procedure OP-43-015, OP-43-005E, or OP-43-010E.

The holding time of samples for radionuclide analyses is 180 days

2.2.4 Sample Shipping

Onsite transfers over nonpublic thoroughfares will be performed in accordance with procedure HNF-PRO-157, *Offsite Hazardous Materials Shipments* Transfer of samples from 105KE to the 1706KE Counting Facility are covered under the SNF Project safety analysis report (SAR), and are not considered shipments, but transfers.

Figure 2-2. Demonstration Apparatus Schematic.



2.2.5 Analytical methods Requirements for Samples

Fixed analytical laboratory parameters for analysis of concrete surface material collected on filters are listed in Table 2-3. Laboratory standard operating procedures (SOP) for analytical methods are in place. Laboratory SOPs and QA plans to be used include analytical procedures and QA plans from the 222-S Laboratory or equivalent procedures from other analytical laboratories. Detection limits achievable by the laboratory will depend on sample quantity available and might also be affected by the matrix and radionuclide activity levels of the sample. The minimum quantity of solid sample required by the laboratory to support all the planned analysis is 10 grams.

Radionuclides that cannot be determined by analysis of solid sample because no analysis method exists or the method minimum detection limit (MDL) is not low enough to support decision making will be scaled to measured radionuclides. The radionuclides that cannot be determined by analysis are C-14, Fe-55, Ni-59, Co-60, Se-79, Mo-93, Zr-93, Nb-94, Pd-107, Cd-113m, Sn-121m, Te-123, Sb-125, I-129, Pm-147, Eu-152, Eu-154, Eu-155, U-232, U-233, Pu-241, Am-242m, Pu-242, and Am-243. The laboratory is not requested to test for these radionuclides. The laboratory is expected to be capable of providing MDLs adequate to support decision making for the analytes listed on Table 2-3. However it may be that, on completion of the analysis, some of the analytes listed on Table 2-3 may require the use of scaling factors.

Table 2-3. Laboratory Analytical Methods, Detection Limits, and Minimum Solid Sample Masses for Selected Contaminants of Concern.

COC	Method Number(s)	Method Description	MDL µCi/g
H-3	LA-504-101[1]/LA-218-114	Distillation/liquid scintillation counting (LSC)	4.60E-04
Ni-63	LA-549-141 or LA-505-163[2]/ LA-285-102	KOH fusion or acid digest, separation, LSC	5.00E-03
Sr-90	LA-549-141 or LA-505-163[2]/ LA-220-101	KOH fusion or acid digest, separation, beta counting	1.65E-03
Tc-99	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	3.40E-05
Sn-126	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	1.14E-05
Cs-134	LA-549-141 or LA-505-163[2]/ LA-548-121	KOH fusion or acid digest with GEA	1.00E+00
Cs-135	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	3.45E-06
Cs-137	LA-549-141 or LA-505-163[2]/ LA-548-121	KOH fusion or acid digest with GEA	1.25E-02
Sm-151	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	1.05E-02
Th-232	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	4.40E-11
Pa-231	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	4.72E-07
U-234	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	3.75E-08

Table 2-3 Laboratory Analytical Methods, Detection Limits, and Minimum Solid Sample Masses for Selected Contaminants of Concern

COC	Method Number(s)	Method Description	MDL µCi/g
U-235	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	4.32E-11
U-236	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	5.18E-10
Np-237	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	3.81E-08
U-238	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	4.37E-10
Pu-238	LA-549-141 or LA-505-163[2]/ LA-953-104	KOH fusion or acid digest, separation, AEA	1.70E-03
Pu-239	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	7.44E-06
Pu-240	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	2.27E-06
Pu-239/240	LA-549-141 or LA-505-163[2]/ LA-953-104	KOH fusion or acid digest, separation, AEA	1.70E-03
AMU-241(Pu)	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	1.65E-02
Am-241	LA-549-141 or LA-505-163[2]/ LA-953-104	KOH fusion or acid digest, separation, AEA	5.50E-03
AMU-242(Pu)	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	3.16E-08
AMU-242(Cm)	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	2.65E-02
Cm-242	LA-549-141 or LA-505-163[2]/ LA-953-104	KOH fusion or acid digest, separation, AEA	5.50E-03
AMU-243(Am)	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	2.00E-06
AMU-243(Cm)	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	5.06E-04
AMU-244(Cm)	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis	8.10E-04
Cm-243/244	LA-549-141 or LA-505-163[2]/ LA-953-104	KOH fusion or acid digest, separation, AEA	5.50E-03

[1]Acid leach preparation procedure may be used in place of water leach procedure
[2]Sample preparation method may be adjusted to achieve required results

AEA = Alpha energy analysis
ICP/MS = Inductively coupled plasma/mass spectrometry
GEA = Gamma energy analysis

Table 2-4 lists fixed analytical laboratory parameters for analysis of water samples collected at the discharge of the surface removal water cleanup system. If water sample analysis for more radionuclides is necessary, the analytical method requirements found in HNF-6495, *Sampling and Analysis Plan for K Basins Debris*, Table 2-7 apply.

Table 2-4. Water Sample Measurement Methods, Detection Limits, and Minimum Sample Volumes for Selected Radionuclide

Contaminant of Concern	Analytical Callout	Analytical Technique	Method Reference*	1706 KE Counting Facility	
				Detection Limits	Volume Requirements
				Liquid (µCi/L)	Liquid (L)
Cs-137	Cs-137 isotopic	Gamma spectroscopy Tennelec	RP-05-033 RP-05-037	1 00E-05	0 5
Total alpha	Gross alpha	Alpha spectroscopy Tennelec	RP-05-031 RP-05-037	1 00E-05	0 5
Total beta	Gross beta	Tennelec	RP-05-037	1 00E-05	0 5

*An equivalent method may be used dependent on the laboratory performing the analysis

2.2.6 Laboratory Quality Control Requirements

A solids sample field blank will be submitted to the laboratory The blank will consist of radiologically inert solid and water placed in a clean sample container with an integral filter

Control measures taken to monitor laboratory performance for solids samples are as follows

- One laboratory method blank for every 20 samples (5 percent of the samples), analytical batch, or sample delivery group (whichever is most frequent) will be carried through the complete sample preparation and analytical procedure. The method blank will be used to document contamination resulting from the analytical process.
- One laboratory control sample or blank spike will be performed for every batch of samples for each analytical method criteria to monitor the effectiveness of the sample preparation process. The results from the analyses will be used to assess laboratory performance.
- A matrix spike sample will be prepared and analyzed for every 20 samples (as applicable to the method) of the same matrix or sample preparation batch, whichever is most frequent. The matrix spike results will be used to document the bias of an analytical process in a given matrix
- Laboratory duplicates or matrix spike duplicates will be used to assess precision and will be analyzed at the same frequency as the matrix spikes.

Control measures taken to monitor laboratory performance for water samples are as follows

- Laboratory gamma spectrometry and gross alpha/beta proportional counting will performance tested daily using National Institute of Standards (NIST) traceable radioactive sources containing a minimum of Am-241, Cs-137, Co-60, or Pu-239/Sr-90 to ensure accurate radionuclide identification and quantification.

- Gamma and alpha/beta systems will be monitored for background radiation levels daily.
- The laboratory will be current in its participation in the environmental measurements laboratory quality assessment program for water and gross alpha/beta measurement.

2.2.7 Instrument/Equipment Testing, Inspection, and Maintenance

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures that ensure minimization of measurement system downtime and avoid inconsistencies in instrument performance.

Laboratories and onsite measurement organizations must maintain their equipment. Instrument preventive maintenance consists of routine inspections, instrument maintenance, and corrective actions. Preventive maintenance is performed in accordance with a schedule based on manufacturer's recommendations, instrument performance history, and use. Each instrument has a logbook to record maintenance events, including the date and name of the person performing the maintenance. The logbook includes routine inspections, significant corrective actions, and instrument maintenance and repairs. For water sample analysis, the laboratory may, instead of using log books, maintain instrument maintenance and repair information in the job control system data base

Spare parts inventories help ensure minimal loss of analytical capability Spare parts include day-to-day consumables and manufacturer's recommended spare parts.

2.2.8 Instrument Calibration and Frequency

Laboratory measurement systems are subject to calibration and/or calibration verification before use for sample analyses. Calibrations are conducted in accordance with the specific analytical methods performed and in the applicable laboratory QA plan

Instruments that fail acceptance criteria shall be investigated and recalibrated. Instruments are not allowed to be used for sample analysis until they meet acceptance criteria The responsible chemist or manager is required to take corrective action when measurement systems fail calibration QC criteria

The minimum requirements of calibration, frequency, and acceptance criteria for solid sample radionuclide analyses are presented HNF-SD-CP-QAPP-016, *222-S Laboratory QA Plan*, Section 7 4 1, Tables 7-1 through 7-4, which are described as follows:

- Table 7-1, "Minimum Requirements of Calibration, Background, and Counter Control for Alpha and Beta Counting"

- Table 7-2, "Minimum Requirements of Calibration, Background, and Counter Control for Gamma Spectrometry'
- Table 7-3, "Minimum Requirements of Calibration, Background, and Counter Control for Alpha Spectrometry"
- Table 7-4, "Minimum Requirements of Calibration, Background, and Counter Control for Beta Spectrometry."

The minimum requirements of calibration, frequency, and acceptance criteria for water sample analyses are presented in the following laboratory procedures.

- SP-005-004, "Calibrate Genie-2000 Spectroscopy."
- SP-05-006, "Calibrate the Tennelec LB5100/W Series III Alpha/Beta Counter."
- SP-05-007, "Calibrate Tennelec LB-5100/W Series IV and 5 Alpha/Beta Counters "
- RP-05-022, "Calibration of the Tennelec LB-5100 Series Low Background Alpha/Beta Counting System."
- RP-05-034, "Calibration of the Genie-2000 Gamma Spectroscopy System."

If other laboratories are contracted, their performance shall be equivalent

2.2.9 Inspection/Acceptance Requirements for Supplies and Consumables

The quality of reagent water is monitored by a resistivity check, assessments of sample blank data, and monthly analysis performed by ion chromatography and ICP. Reagent water checks are described more fully in laboratory procedures or the laboratory QA plan.

Percent purity levels of gases or reagents necessary for quality analysis are listed in each analytical procedure The quality of gases or reagents is monitored by performing the preparation blank analysis

Standards that are prepared and used for the first time are verified against existing working standards or against an independent source to ensure accuracy of the standard.

The Standards Laboratory maintains records that provide traceability of the prepared standards to the original standard reference materials

Radioactive material standards are verified by preparing and counting mounts. The results of the count are compared to the calculated certified value.

The requirements of this section do not apply to the water sample analysis laboratory because reagent water is not used in the analysis methods and standards are purchased rather than made up by the laboratory. Standards purchased to support water sample analysis shall be NIST traceable.

2.3 ASSESSMENT/OVERSIGHT FOR SAMPLING AND ANALYSIS

K Basins QA may conduct random surveillances and assessments in accordance with SNF-4948, *SNF Project QA Program Plan*, to verify compliance with requirements outlined in this sampling and analysis plan, project work packages, procedures, and regulatory requirements. Correction of nonconformances shall be in accordance with applicable facility procedures and the 222-S laboratory per the HASQARD and SNF Project per HNF-PRO-052, *Corrective Action Management*

2.4 DATA REVIEW, VALIDATION, AND USABILITY

Requirements for review and evaluation of data usability are described in the following sections.

2.4.1 Data Review and Verification Requirements

Data verification will be performed on analytical data sets to ensure that sampling and chain-of-custody documentation are complete, sample numbers can be tied to the specific sampling location, samples were analyzed within the required holding times, and analyses meet the data quality requirements specified in the characterization plan.

Analytical and Waste Management Services personnel will review the solid sample analysis data. Laboratory personnel will perform a peer review of all solid sample analytical data The peer review will be conducted by a person trained to the particular analytical method being reviewed DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD), Volume 4, describes the data review that the laboratory will perform. The laboratory will use its own data review procedures that meet the HASQARD criteria to review data before they are sent to the K Basins Project

Analytical and Waste Management Services personnel will review the water sample analysis data Laboratory personnel will perform a review of all the water sample analytical data as per the following procedures.

- RP-05-033, "Operation of the Canberra Genie-2000 Gamma Spectroscopy System "
- RP-05-037, "Operation of the Tennelec LB-5100 Series Low Background Alpha/Beta Counting System Using Eclipse Software."

Waste Management Services personnel or their designees will review the data and the summary QC with respect to the criteria in this SAP

Survey measurement systems will be verified by a review of 5 percent of the documentation to ensure that calibration checks are performed in accordance with the methods and that dates of survey and analysis locations are properly documented The review shall be performed by Waste Management Services personnel

2.4.2 Data Validation

Analytical and survey data will not undergo a third-party validation

2.4.3 Reconciliation With User Requirements

Following review, the laboratory data will be assessed by Waste Management Services personnel against the criteria in Section 2.1 4 Assessment will include review of quantitative DQOs (e g., accuracy, precision, completeness, and detection limits) and the preparation of a summary report The final report will include an evaluation of the overall adequacy of the total measurement system with regard to the DQO of the data generated These quantitative DQOs are defined as follows

Precision

If calculated from duplicate measurements

(1)

where:

RPD	=	relative percent difference
C_1	=	larger of the two observed values
C_2	=	smaller of the two observed values

If calculated from three or more replicates, use RSD rather than RPD

$$RSD = \left(s / \bar{y}\right) \times 100 \qquad (2)$$

where·

RSD	=	relative standard deviation
s	=	standard deviation
$\bar{y}$	=	mean of replicate analyses.

Standard deviation, s, is defined as follows:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(y_i - \bar{y})^2}{n-1}} \qquad (3)$$

where

s	=	standard deviation
y_i	=	measured value of the i^{th} replicate
$\bar{y}$	=	mean of replicate measurements
n	=	number of replicates.

Accuracy

For measurements where matrix spikes are used:

$$\%R = 100x\left[\frac{S-U}{C_{sa}}\right] \qquad (4)$$

where

%R	=	percent recovery
S	=	measured concentration in spiked aliquot
U	=	measured concentration in unspiked aliquot
C_{sa}	=	actual concentration of spike added

For situations where a LCS is used instead of or in addition to matrix spikes:

$$\%R = 100\left[\frac{C_m}{C_{srm}}\right] \qquad (5)$$

where:

%R	=	percent recovery
C_m	=	measured concentration of LCS
C_{srm}	=	actual concentration of LCS.

Completeness

Defined as follows for all measurements:

$$\%C = 100x\left[\frac{V}{T}\right] \qquad (6)$$

where.

%C	=	percent completeness
V	=	number of measurements judged valid
T	=	total number of measurements.

Detection Limit

Defined as follows for metals measurements.

$$MDL = t_{(n-1,1-\alpha=0\ 99)} xS \tag{7}$$

where

MDL	=	method detection limit
S	=	standard deviation of the replicate analyses
$t_{(n-1,\ 1-\alpha=0\ 99)}$	=	students' t-value appropriate to a 99 percent confidence level and a standard deviation estimate with n-1 degree of freedom

2.5 DATA QUALITY ASSESSMENT

Data quality assessment is performed by Waste Management Services personnel or designee after data review of the survey and standard fixed laboratory data in accordance with Section 2 4. The review by Waste Management Services personnel or designee must include evaluation of the method accuracy, precision, detection limits and completeness as applicable in Sections 2.1.4, 2.2.6, and 3 5. Correction of nonconformances shall be in accordance with applicable facility procedures and the 222-S laboratory per the HASQARD and SNF Project per HNF-PRO-052.

Review The Project DQOs. This includes the conceptual model and any assumptions included in the data collection design. Because data collection for this project is not determined by a statistical design, hypotheses and error tolerances are not included in the original DQOs. However, qualitative assessment of both the fixed laboratory data and the survey data can be performed.

No statistical data quality assessment is performed on analytical data because no random sampling is conducted and only one sample per surface layer will be collected.

No statistical data quality assessment is performed for survey data as it is collected on all waste containers

The estimated concentrations of radionuclides will be compared by the project to the applicable BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (ERDF WAC) for designation. The free liquid content of the package will be in compliance with the ERDF WAC

2.6 ANALYTICAL DATA REPORTS

This SAP requires a summary data report with QA review for solid sample reports from the laboratory. This report includes a case narrative and analytical QC, such as percent recovery on the LCSs, matrix spikes, relative percent differences (RPD) on duplicate or matrix spikes and matrix spike duplicates, and method blank results.

This SAP requires a data report with professional review be generated for water sample reports. The water sample reports shall include the following:

- Instrument serial number
- Sample volume
- Calibration expiration data
- Measured sample activity and associated measurement uncertainty for Cs-137, gross alpha, and gross beta.

Analytical data reports shall be managed in accordance with HNF-RD-210, *Records Management Program*

3.0 FIELD RADIOLOGICAL SURVEY

This section builds on the DQO process, which is summarized in Chapter 1. The following sections summarize the radiological survey design discussed in previous sections. Field surveys consist of radiation dose measurements of either the concrete wall and floor or the exterior of waste containers. The project objective is to remove wall and floor basin surface from the K East Basins as necessary to support radiation dose reduction at the basin

Field radiation dose measurements are used to determine the radionuclide inventory of a waste package. The radiation dose of either the concrete surface or exterior of the waste package is used to estimate the Cs-137 content of the waste package. The other radionuclides are estimated by scaling to Cs-137 based on the radionuclide distribution developed for the waste

3.1 RADIATION DOSE-TO-CURIE CONVERSION

The radiation dose survey information is used to estimate the inventory of Cs-137 in a waste container Cesium 137 is the dominate dose-generating nuclide, although other gamma emitters are present in the K Basins The most common (Co-60, Eu-152, Eu-154, and Eu-155) generally are at concentrations of less than 10 percent of the Cs-137concentration By using the conservative assumption that all measured radiation dose rate is from Cs-137, ignoring other gamma-emitting radionuclides, if present, would lead to an overestimation of the Cs-137 content of the waste The presence of other gamma emitting radionuclides relative to Cs-137 will be evaluated based on analytical results and the dose-to-curie model will be adjusted if required.

The Cs-137 inventory of a waste package will be determined using one of two possible dose-to-curie conversion models:

1. A radiation-dose-to-Cs-137-inventory curve developed for a concrete surface. A radiation dose measurement at the concrete surface will be recorded as the surface is being removed The curve converting surface radiation dose to Cs-137 inventory will be developed using modeling validated with sample analysis and dose measurements.

2. A radiation-dose-to-Cs-137-inventory curve developed for a waste package. The radiation dose around a waste package surface will be recorded A curve converting dose to Cs-137 inventory for a package geometry will be developed using modeling validated with measured results.

WHC-SD-WM-PROC-020, *Procedure for Categorizing and Inventorying Waste in Standard Containers,* provides radiation-dose-to-Cs-137-inventory relationships developed for various waste packages, these relationships can be used for this waste The technical basis for this procedure is presented in WHC-SD-WM-RPT-267, *Basis for Radiation dose Rate to Curie Assay Method* Although the technical basis document was prepared for tank waste, the basic premise of the document is that the major contributor to the measured radiation dose rate is Cs-137 That premise also is appropriate for the K Basin waste.

3.2 RADIONUCLIDE INVENTORY ESTIMATE BASED ON WASTE CS-137 CONTENT

During the DQO process, a final list of COCs was generated The logic and approach for selecting the final list of COCs is discussed in Appendix A

The estimate of radiological content for waste will rely on scaling factors of COCs to a measured Cs-137 content. The Cs-137 content will be estimated through the radiation dose conversions already discussed The scaling factors of COCs to Cs-137 will be estimated based on concrete residue analysis results and the N Reactor fuel ORIGEN II computer calculations as presented in HNF-6273, Table B-1 If sludge still resides on the floor or in basin water at the time of floor surface removal, the floor scaling factors will be evaluated and adjusted to account for the sludge contribution.

3.3 RADIATION DOSE TO RADIONUCLIDE INVENTORY QUALITY CONTROL REQUIREMENTS

A water sample collected at the discharge of the concrete surface removal system will be collected during the surface removal demonstration and weekly during full-scale operation After receipt of data collected from the demonstration, action levels will be set to identify when excessive contamination is being put into the basin from the surface removal system that could affect the waste characterization The weekly water samples will be evaluated against the action levels to determine if action is required.

3.4 RADIOLOGICAL SURVEYS

Radiological surveys of the outside of waste packages for radiological control purposes, estimating radionuclide inventory, and to comply with ERDF waste surface contamination acceptance criteria will be performed and reported in accordance with HNF-13536, *PHMC Radiological Control Procedures.*

The instruments shall be used with HNF-13536.

Radiological surveys of the concrete surface for determining if adequate surface material has been removed and estimating radionuclide inventory will be performed in accordance with HNF-13536.

3.5 QUALITY CONTROL REQUIREMENTS FOR RADIOLOGICAL SURVEYS

This characterization effort relies heavily on field measurements to determine the waste package content of Cs-137, which will be used to estimate all other radionuclides using scaling factors developed from laboratory analysis results and the N Reactor ORIGEN II computer code

Quality assurance is built into each phase of the characterization as field instrument operational checks that monitor field instrumentation performance.

Alpha surveys, beta/gamma surveys, gamma surveys, and radiation dose rate measurements will be used Instruments will be calibrated against known standards representative of the instrument response to the identified analyte. The instrument will be within the calibration period specified by the instrument procedure

Quality control measures taken to support field operations performance, including daily calibration checks before and after use, will be performed and documented on each instrument used to survey or characterize waste. These checks will be performed as defined in the appropriate instrument procedure Correction of nonconformances shall be in accordance with applicable facility procedures and HNF-PRO-052

3.6 INSTRUMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

Measurement and testing equipment used in the field will be subject to acceptance testing and preventive maintenance measures to ensure that measurement system down time is minimal. Maintenance requirements, such as parts lists and instructions, and documentation of routine maintenance, will be performed according to the general program (HNF-5173, *PHMC Radiological Control Manual*), as well as any additional measures specified in the specific instrument procedure cited in Section 3 4

3.7 INSTRUMENT CALIBRATION AND FREQUENCY

Instruments used for surveys and screening for offsite sample shipment will be calibrated in accordance with HNF-13536, *PHMC Radiological Control Procedures*. The results from all instrument calibration activities shall be recorded as defined in the program procedure. Control documents must specify when the instrument was last calibrated, the results of that calibration, and the due date for new calibration.

3.8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Procurement activities related to radiological survey will be limited to performing acceptance testing for all instruments and standards used as described in HNF-5173 and specific instrument procedures.

3.9 FIELD SURVEY DOCUMENTATION

Field documentation will be kept in accordance with HNF-13536. Survey data reports shall be managed in accordance with HNF-RD-210

3.10 WASTE HANDLING AND CUSTODY REQUIREMENTS

All waste handling, removal of free liquid, shipping, and custody requirements will be met in accordance with Procedure OP-46-006, *Processing Contaminated Waste for ERDF Disposal*, or a new procedure

In addition, radioactive waste will be surveyed for shipment in accordance with HNF-13536 Radiological survey tags will be attached to individual waste containers (e.g., drums, boxes)

3.11 WASTE AND SAMPLE SHIPPING

Waste and sample packaging for shipping will be performed in accordance with Procedure OP-46-006 or a new procedure. The samples or waste will be shipped in accordance with HNF-PRO-157, *Offsite Hazardous Materials Shipments* Currently, the samples are shipped to onsite laboratories and unused samples are sent back to the generator The contracts with offsite laboratories specify that the laboratory dispose of any remaining sample and the waste associated with analysis.

4.0 HEALTH AND SAFETY

All field operations required by this SAP will be conducted in accordance with the HASP (HNF-4747)

The HASP identifies the primary hazards associated with waste management activities. Some of these hazards are direct radiation exposure, potential personnel contamination, potential inhalation of airborne concentrations of radioactive materials, and exposures to hazardous substances. Rather than list the requirements to mitigate and control radiological and hazardous chemical exposures, the HASP references documents that provide the necessary direction to mitigate and control these hazards To assist in developing subtier- or task-/subproject-specific implementation of the HASP, the Automated Job Hazards Analysis (AJHA) will be used in accordance with HNF-PRO-079, *Job Hazard Analysis*. The AJHA is a computer-based application to help planners identify the potential hazards associated with a job task and to implement the proper controls based on the hazards identified Proper use of the AJHA in conjunction with the project HASP (HNF-4747), plus specifics associated with the task, will constitute acceptable subtier- or task-/subproject-specific implementation of the HASP In accordance with 29 CFR 1910 120(6)(1)(v) (OSHA99A), the HASP shall be made available to FH employees and any contractor or subcontractor involved with hazardous waste operations

FH has a robust and mature radiation protection program This program is described in HNF-5173. HNF-5173 fully implements 10 CFR 835, "Occupational Radiation Protection," as currently amended The planning of work involving radiation and radioactive materials hazards is further described in HNF-PRO-1623, *Radiological Work Planning Process* Implementation of radiological work and radiation protection activities is detailed in procedures Procedures address roles and responsibilities, qualifications, training, implementation of the ALARA philosophy, external and internal dosimetry, monitoring and surveillance, work control mechanisms (e g., radiation work permits, and access and entry requirements), self-assessments, and use of specific radiation monitoring devices and meters

The FH Chemical Management Program (CMP), as described in HNF-PRO-10468, *Chemical Management Process*, in conjunction with implementation of the AJHA in accordance with HNF-PRO-079, will be relied on to protect the workers, the general public, and the environment from specific chemical substances and their associated hazards. The CMP provides direction for the acquisition, storage, transportation, use, final disposition, record keeping, and management review of program performance for chemicals at the Hanford Site

5.0 REFERENCES

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HNF-6273, 2000, *Data Quality Objectives Process for Designation of K Basins Debris*, Rev 0, Fluor Hanford, Inc , Richland, Washington.

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HNF-PRO-079, *Job Hazard Analysis*, Rev 6, Fluor Hanford, Inc., Richland, Washington.

HNF-PRO-157, *Offsite Hazardous Materials Shipments* , Rev. 6, Fluor Hanford, Inc., Richland, Washington.

HNF-PRO-1623, *Radiological Work Planning Process,* Rev. 5, Fluor Hanford, Inc , Richland, Washington

HNF-PRO-10468, *Chemical Management Process*, Rev 1, Richland, Washington

HNF-PRO-10588, *Records Management Process*, Rev. 2, Fluor Hanford, Inc , Richland Washington

HNF-RD-210, *Records Management Program*, Rev 1, Fluor Hanford, Inc., Richland, Washington

HNF-SD-CP-QAPP-016, 2003, *222-S Laboratory QA Plan*, Rev. 7, Fluor Hanford, Inc , Richland, Washington

OP-46-006, *Processing Contaminated Waste for ERDF Disposal*, Rev. 1, Spent Nuclear Fuels Operations Project Technical Procedure, Fluor Hanford, Inc., Richland, Washington

OP-43-005E, *Collect Routine Water Samples at 105-KE (Weekly)*, Rev. 3L, Spent Nuclear Fuels Operations Project Technical Procedure, Fluor Hanford, Inc , Richland, Washington.

OP-43-010E, *Collect Center of Basin Air Permit Water Sample*, Rev 1L, Spent Nuclear Fuels Operations Project Technical Procedure, Fluor Hanford, Inc., Richland, Washington.

OP-43-015, *Collect Special Water Samples from Routine and Nonroutine Locations*, Rev. 1O, issued August 27, 2003, Spent Nuclear Fuels Operations Project Technical Procedure, Fluor Hanford, Inc , Richland, Washington

RP-05-022, *Calibration of the Tennelec LB-5100 Series Low Background Alpha/Beta Counting System*, Rev 1A, Spent Nuclear Fuel Project administrative procedure, Fluor Hanford, Inc , Richland, Washington.

RP-05-034, *Calibration of the Genie-2000 Gamma Spectroscopy System*, Rev. 0B, Spent Nuclear Fuel Project administrative procedure, Fluor Hanford, Inc., Richland, Washington

RP-05-033, *Operation of the Canberra Genie-2000 Gamma Spectroscopy System*, Rev.0C, Spent Nuclear Fuel Project administrative procedure, Fluor Hanford, Inc., Richland, Washington.

RP-05-037, *Operation of the Tennelec LB-5100 Series Low Background Alpha/Beta Counting System Using Eclipse Software*, Rev. 0A, Spent Nuclear Fuel Project administrative procedure, Fluor Hanford, Inc , Richland, Washington.

SNF-4948, *SNF Project QA Program Plan*, Rev. 3, Fluor Hanford, Inc., Richland, Washington

SP-05-004, *Calibrate Genie-2000 Spectroscopy*, Rev. 0D, Spent Nuclear Fuel Project administrative procedure, Fluor Hanford, Inc., Richland, Washington.

SP-05-006, *Calibrate the Tennelec LB5100/W Series III Alpha/Beta Counter*, Rev 3C, Spent Nuclear Fuel Project administrative procedure, Fluor Hanford, Inc., Richland, Washington.

SP-05-007, *Calibrate Tennelec LB-5100/W Series IV and 5 Alpha/Beta Counters*, Rev. 1B, Spent Nuclear Fuel Project administrative procedure, Fluor Hanford, Inc , Richland, Washington

TN 8-001-13, *General Training Administration*, Spent Nuclear Fuel Project procedure, Fluor Hanford, Inc., Richland, Washington.

Toxic Substances Control Act of 1976, 15 USC 2601, et seq.

WHC-SD-WM-PROC-020, 1996, *Procedure for Categorizing and Inventorying Waste in Standard Containers*, Rev. 0, Westinghouse Hanford Company, Richland, Washington

WHC-SD-WM-RPT-267, 1996, *Basis for Dose Rate to Curie Assay Method*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Work Package 1K-03-01361, *Demonstration of Hydrolasing at 105K East (Hot Demo)*

APPENDIX A

DATA QUALITY OBJECTIVES SUMMARY REPORT FOR WASTE DISPOSITION OF NONCOMPLICATED WASTES K EAST BASIN WALL AND FLOOR SURFACE REMOVED RESIDUE

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APPENDIX A

DATA QUALITY OBJECTIVES SUMMARY REPORT FOR WASTE DISPOSITION OF NONCOMPLICATED WASTES KE BASIN WALL AND FLOOR SURFACE REMOVED RESIDUE

CONTENTS

ATTACHMENTS

FIGURES

TABLES

TERMS

ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
CWC	Central Waste Complex
DQO	data quality objective
DS	decision statement
ERDF	Environmental Restoration Disposal Facility
LLBG	Low-Level Burial Ground
MDL	method detection limit
MTCA	*Model Toxics Control Act*
PCB	polychlorinated biphenyl
TC	Toxic Characteristic
TSCA	*Toxic Substances Control Act of 1976*
TSD	treatment, storage, and disposal
UTS	Universal Treatment Standards
WAC	*Washington Administrative Code*

METRIC CONVERSION CHART

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	metric ton
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius
Radioactivity		
Picocuries	37	millibecquerel

Out of Metric Units

If You Know	*Multiply By*	*To Get*
Length		
millimeters	0.039	inches
centimeters	0.394	inches
meters	3.281	feet
meters	1.094	yards
kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
hectares	2.47	acres
Mass (weight)		
grams	0.035	ounces
kilograms	2.205	pounds
metric ton	1.102	ton
Volume		
milliliters	0.033	fluid ounces
liters	2.1	pints
liters	1.057	quarts
liters	0.264	gallons
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity		
millibecquerel	0.027	picocuries

A1.0 INTRODUCTION

The penetration of the K East Basin concrete by radiation-emitting elements requires that the wall and floor surfaces be removed to reduce radioactive doses when the basin water is removed The waste produced by this activity is rock and pulverized cement abraded from the concrete. The removed rock and cement residue are collected on a strainer and filter. The waste will be packaged, treated if necessary, and disposed of to the Environmental Restoration Disposal Facility (ERDF) or another Hanford Site waste management facility

A1.1 PROJECT OBJECTIVES

The purpose of this data quality objective (DQO) process is to support decision-making activities as they pertain to the designation of waste generated by the removal of the K East Basin wall and floor surfaces by hydrolasing. The document will identify the decisions to be made and the information needed to support decision making for disposition of the residue from removing the K East Basin surface (BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*)

A1.2 PROJECT ASSUMPTIONS

The DQO was developed on the basis of the following statements:

- Waste that complies with the ERDF waste acceptance criteria (WAC) or can be treated to comply with the ERDF WAC will be disposed of to the ERDF. If the waste is not sent to ERDF, the waste will be sent to another Hanford Site waste management facility

- The waste will be decanted and/or absorbed as necessary to comply with the ERDF acceptance criteria.

- The source of radiological contamination is the spent fuel in the basins. The mechanism for contamination of the walls and floor is migration of radionuclides via water into the pores of the concrete. The walls are free of fuel and sludge. The floor will be free of fuel and sludge or, if sludge is present on the floor, the quantity can be estimated before surface removal. If sludge is present on the floor, the waste produced is the sum of the hydrolasing residue of the floor and the sludge.

- The amount of sludge present on the floor will be controlled to ensure minimal sludge content.

- The sludge on the floor is not regulated under WAC 173-303, "Dangerous Waste Regulations," but is regulated as polychlorinated biphenyl (PCB) remediation waste under the *Comprehensive Environmental Response Compensation and Liability Act of 1980* (CERCLA) of which the *Toxic Substances Control Act of 1976* (TSCA) is an applicable or relevant and appropriate requirement (ARAR).

- The surface removal apparatus deployed in the basin for demonstration testing will be similar in design and operation to that used for full-scale operations.

- The basin wall area selected for the hydrolasing demonstration is representative of the basin walls and floor inventory of actinide and other elements relative to cesium inventory The cesium inventory in the concrete surface will vary with location generally within a factor of three and will be measured as a basis for estimate (PNNL-14407, *Underwater Determination of Radionuclide Levels in 105-KE Basin Floor and Walls Using a Gamma-Ray Detector System*)

- The isotopes of each element act the same chemically, so the isotopic distribution from the contamination source will be the same for each element in the hydrolase residue

- Fuel and sludge will be removed to the extent required before the floor will be hydrolased generating this waste stream.

- The aggregate (rock) content of concrete is not penetrated by radioactive material

The issue identified by the DQO process is as follows·

The packaging used to transport and dispose of the waste probably will require shielding and qualification of the package configuration

A1.3 BACKGROUND INFORMATION

The K East Basin is located in the 100K Area. The fuel basin is a large open-topped concrete pool containing approximately 4 9 million liters (1 3 million gallons) of demineralized water The basin was constructed in the early 1950s The basin was used to store spent nuclear fuel from the K East reactor until the early 1970s, when the reactor was removed from service In 1975 the K East Basin began being used to store spent nuclear fuel from N Reactor and currently is used to store fuel primarily from N Reactor (DOE/EIS-0245, *Environmental Impact Statement-Management of Spent Nuclear Fuel from the K Basins at the Hanford Site*). The K East Basin walls and floor are bare concrete, coatings were not applied to the surfaces. The sludge in the bottom of the basin contains elements from deteriorating spent fuel

Soon after N Reactor fuel began being stored, the basin water quality deteriorated because of loading with radionuclides. The water treatment loop was upgraded in 1978 by adding filtration and ion exchange removal of Cs-137 Because of continued water loading with Sr-90 and H-3, further water treatment system upgrades were completed in 1986 After these upgrades, the water quality improved markedly, generally showing more than a factor of 10 reduction in radionuclide concentrations The wall inventory is considered to have accumulated during the period of poor water quality (WHC-EP-0877, *K Basin Corrosion Program Report*) In general the K East Basin water did not experience biological growth, however some spot applications of algaecides have occurred Hydrogen peroxide is still being employed as a spot algaecide

A1.4 CONTAMINANTS OF CONCERN

A list of the contaminants of concern (COC) for the facility under investigation is generated by initially listing all of the contaminants of potential concern (COPC) based on historical process operations Then, those with short half-lives, those that are not environmentally regulated, and those for which process knowledge and analytical data are sufficient to confirm that insignificant concentration exist are excluded, leaving the list of COCs.

A1.4.1 Total List of Contaminants of Potential Concern

Table A-1 identifies all of the COPCs for each waste stream expected to be generated The waste streams are numbered for tracking purposes These waste stream numbers do not represent waste code numbers

Table A-1 Contaminants of Potential Concern for Each Waste Stream.

WS #	Waste Stream	Known or Suspected Source of Contamination	Type of Contamination (General)	COPCs (Specific)
1	Residue from surface removal of KE Basin wall and floor collected on filter and strainer The residue will include basin water and basin wall material	Spent fuel in basin	Radionuclides, TC metals	Radionuclides[1]
		Basin sludge	PCB, TC metals, radionuclides (spent fuel is original source of nuclides)	Radionuclides[1], Hg, Se, As, Ba, Cd, Cr, Pb, Ag, Tl, Ni, Be, Sb, PCB
		Concrete material of the wall	High pH lime and carbonates	pH, composition of concrete
		Basin water	Radionuclides (from spent fuel), liquid in filter cake	Radionuclides[1], free liquid, sodium fluorescein, H_2O_2, NaOCl, and $Ca(OCl)_2$[2]
		Equipment located in the basin	Hydraulic fluid	Polyalkanes

[1]Radionuclides are listed in Table B-1 of HNF-6273, 2000, *Data Quality Objectives Process for Designation of K Basin Debris*, Rev 0, Fluor Hanford, Inc , Richland, Washington

[2] WHC-EP-0877, 1995, *K Basin Corrosion Program Report*, Rev 0, Westinghouse Hanford Company, Richland, Washington

COPC	= Contaminant of potential concern	TC	= Toxic characteristic
PCB	= Polychlorinated biphenyl	WS	= Waste stream

A1.4.2 Contaminant of Potential Concern Exclusions

Table A-2 lists the COPCs to be excluded from the investigation. The rationale for these exclusions are typically based on physical laws, process knowledge, task focus, or other mitigating factors, as explained in Section A1.4.

Table A-2. Excluded Contaminants of Potential Concern with Rationale for Their Exclusion.

WS #	COPCs	Rationale for Exclusion
1	Cr-51, Mn-54, Sr-89, Ru-106, Ag-110m, Sn-119m, Te-125m, Sb-126, Sb-126m, Ba-140, Ce-144, Th-231, Th-234, Pa-234m, and Pa-234	Nuclides removed from consideration because of <2 years half life, which is not reportable per ERDF waste acceptance criteria [1]
	Kr-85	Element exists as a gas, which will not be retained in wall, floor, or water [2]
	Ba-133	Element is not expected to be in spent fuel
	Pu-244, Cm-245, Cm-246, Cm-247, Cm-248 Pb-210, Ra-226, Ac-227, Ra-228, Th-229, Th-230, Gd-152, Sm-147, Eu-150, Be-10	Estimate of possible radionuclide content is <1 pCi/g of waste, which is not reportable per ERDF waste acceptance criteria See Attachment A
	Sodium fluorescein	The chemical is not regulated as a dangerous waste [3]
	H_2O_2, NaOCl, and $Ca(OCl)_2$	Small quantities (10 ppm basin concentration) used for local applications Hypochlorites would have to be >1% to be Washington State toxic, which is not credible Hydrogen peroxide would have to > 01% to be Washington State toxic, which is not credible Also, hypochlorites and peroxides chemicals react with environment to decompose.[3]
	Composition of concrete	Analysis of concrete at Hanford Site shows it is not regulated under WAC 173-303 [4]
	Hg, Se, As, Ba, Cd, Cr, Pb, Ag, Tl, Ni, Be, Sb	The quantities of these metals in sludge are below regulatory thresholds and sludge is more likely to contain metals than concrete [5,6] Concrete does not exhibit an affinity for metals
	pH	The chemistry of aged concrete removes the characteristic of high pH by hydrolysis of lime [2]
	Hydraulic fluid	A 15-gal one-time spill in basin The material would float and be removed in the water treatment system, not adhering to the wall or floor

[1]HNF-EP-0063, 2003, *Hanford Site Solid Waste Acceptance Criteria*, Rev 9, Fluor Hanford, Inc , Richland, Washington

[2]Lea, F M , 1970, *The Chemistry of Cement and Concrete*, 3rd Ed , Chemical Publishing Co., New York, New York

[3]Registry of Toxic Effects of Chemical Substances

[4]WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended, Olympia, Washington

[5]Correspondence No 0101943, "Contract No DE-AC06-96RL13200- Completion of Waste Designation for K Basin Sludge Waste Streams," letter from P G Loscoe, RL, to D R Sherwood, EPA, and M A Wilson, Ecology, dated March 27, 2001, Richland, Washington

[6]HNF-SD-SNF-TI-015, 2002, *Spent Nuclear Fuel Project Technical Data book*, Vol 2, "Sludge," Rev 9, Fluor Hanford, Inc , Richland, Washington.

ERDF = Environmental Restoration Disposal Facility
COPC = Contaminant of potential concern
WAC = *Washington Administrative Code*
WS = Waste stream

A1.4.3 Final List of Contaminants of Concern

Table A-3 lists the COCs for each waste stream number to be carried through the remainder of the DQO process

Table A-3 Final List of Contaminants of Concern.

WS #	COCs
1	Th-232, Pa-231, U-232, U-233, U-234, U-235, U-236, Np-237, U-238, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Am-242m, Pu-242, Am-243, Cm-242, Cm-243, Cm-244, Sm-151, Eu-152, Eu-154, Eu-155, H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Se-79, Sr-90, Mo-93, Zr-93, Nb-94, Tc-99, Pd-107, Cd-113m, Sn-121m, Te-123, Sb-125, Sn-126, I-129, Cs-134, Cs-135, Cs-137, Pm-147
	PCB
	Free liquid

COC = Contaminant of concern
PCB = Polychlorinated biphenyl
WS = Waste stream

A1.5 ACTION LEVELS

The action levels that apply to each of the COCs are presented in Table A-4 with the basis for each action level The action levels for waste designation are presented in Table A-4 and are generally based on regulatory thresholds for waste designation

Table A-4. List of Action Levels.

WS #	COCs	Action Level	Basis
1	Radionuclides	1 pCi/g	Reportable limit for ERDF
	PCB	PCB 10 mg/kg	UTS limit per 40 CFR 268 48 evaluated as nonwastewater
		PCB >50 ppm, liquid PCB 500 ppm	40 CFR 761 ERDF Waste Acceptance Criteria
	Free liquid	Free liquid as per paint filter test (9095) (EPA 1997)	Disposal of liquids as governed by WAC 173-303-140(4)(b)

40 CFR 761, 1992, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *Code of Federal Regulations*, as amended

EPA, 1997, *Test Methods for Evaluating Solid, Waste Physical/Chemical Methods*, SW-846, 3rd Edition, as amended by Updates, U S Environmental Protection Agency, Washington, D C

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended, Olympia, Washington

CFR = *Code of Federal Regulations*
COC = Contaminant of concern
ERDF = Environmental Restoration Disposal Facility
PCB = Polychlorinated biphenyl
UTS = Universal Treatment Standards
WAC = *Washington Administrative Code*
WS = Waste stream

A1.6 WASTE GENERATION–CONCEPTUAL MODEL

The surface layer of the K East Basin concrete walls and floor is removed using hydrolasing technology then collected on strainer and filter media. The removed material consists of rock that will be caught primarily on a strainer with fine cement residue that will be caught on a filter (*Technology Demonstration Underwater Hydrolasing, Phase 0* [S. A Robotics 2003]). When residue has been collected, it will be packaged for shipment and disposal Free-standing water will be removed and absorbent added as necessary to comply with disposal requirements.

A1.7 STATEMENT OF THE PROBLEM

To package waste consisting of removed surface of the concrete K East Basin walls and floor for disposal to ERDF, data regarding the radionuclides and chemical constituent concentrations, basin or package surface dose to activity concentrations in a waste package, and physical characteristics of the waste are needed

A2.0 DECISIONS AND INPUTS

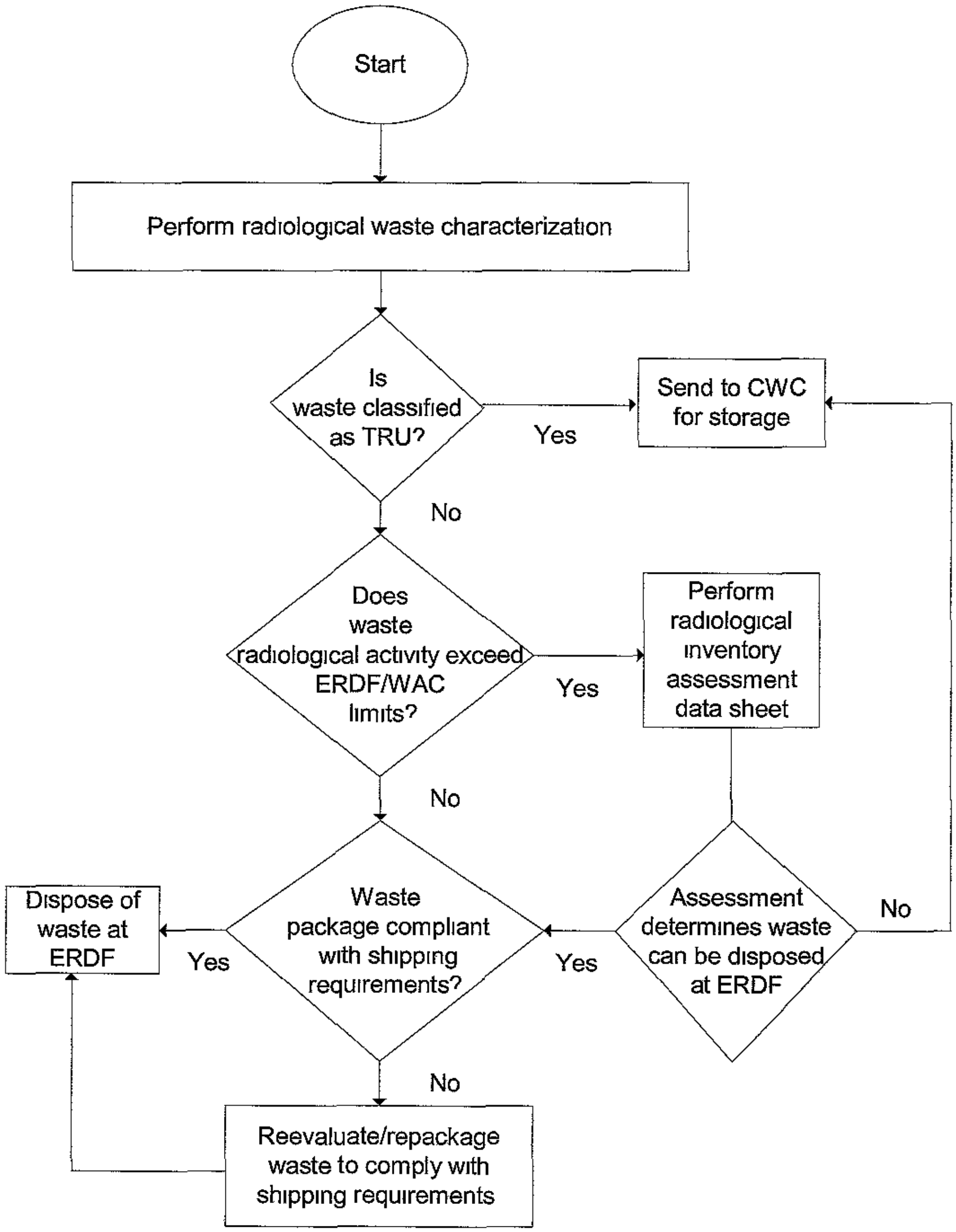
Table A-7 presents the decision statements (DS) relevant to waste designation, which were developed using the logic diagram presented in Figure A-1 for waste designation.

Table A-7 Decision Statements for Designation of K East Basin Removed-Surface-Generated Waste

DS #1 – Determine if the waste <u>is</u> a listed dangerous waste and will be evaluated for treatment and disposal at a candidate facility (e.g , ERDF or CWC), <u>OR</u> if the material <u>is not</u> a listed dangerous waste and will be evaluated for disposal at a candidate facility (e g , ERDF or LLBG)
DS # 2 – Determine if the waste <u>is</u> a characteristic waste and will be evaluated for treatment and disposal at a candidate facility (e g , ERDF or CWC), <u>OR</u> if the material <u>is not</u> a characteristic waste and will be evaluated for disposal at a candidate facility (e g., ERDF or LLBG)
DS #3 – Determine if the waste <u>is</u> a toxic dangerous waste and will be evaluated for treatment and disposal at a candidate facility (e g , ERDF or CWC), <u>OR</u> if the material <u>is not</u> a toxic dangerous waste and will be evaluated for disposal at ERDF or LLBG
DS #4 – Determine if the waste <u>is</u> a persistent waste and will be evaluated for treatment and disposal at a candidate facility (e g , ERDF or CWC), <u>OR</u> if the material <u>is not</u> a persistent waste and will be evaluated for disposal at a candidate facility (e g , ERDF or LLBG)
DS #5 – Determine if the waste is a PCB waste and will be evaluated for disposal at a candidate facility (e g , ERDF or CWC), <u>OR</u> if the material is not a PCB waste and will be evaluated for disposal at a candidate facility (e g , ERDF or LLBG)
DS #6 – Determine if the waste <u>does exceed</u> the ERDF radiological waste acceptance criteria and must be stored/disposed at another candidate facility (e g , CWC/LLBG), <u>OR</u> if the material <u>does not exceed</u> the ERDF radiological waste acceptance criteria and can be disposed at ERDF
DS #7 – Determine if the waste <u>is</u> land disposal restricted and requires treatment prior to disposal, <u>OR</u> if the material <u>is not</u> land disposal restricted and may be disposed in an onsite facility without treatment
DS #8 – Determine if the waste package will have to be engineered to comply with shipment requirements, OR if the waste package does not require engineering it is usable as is to ship waste

CWC = Central Waste Complex
ERDF = Environmental Restoration Disposal Facility
LLBG = Low-level burial grounds
PCB = Polychlorinated biphenyl
TSD = Treatment, storage, and disposal

Figure A-1. Waste Designation Logic Diagram.



Legend

CWC = Central Waste Complex
ERDF = Environmental Restoration Disposal Facility
TRU = transuranic (waste materials contaminated with 100 nCi/g of transuranic materials having half-lives longer than 5 years)

A2.1 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS

Table A-8 specifies the information (data) required to satisfy each DS identified in Tables A-7 and identifies whether these data already exist For existing data, the source references are provided with a qualitative assessment of whether the data are of sufficient quality to satisfy the corresponding DS. The qualitative assessment is based on an evaluation of corresponding quality control data (e.g , spikes, duplicates, and blanks), detection limits, data collection methods, etc

A2.2 ANALYTICAL PERFORMANCE REQUIREMENTS

Table A-9 defines the analytical performance requirements for the data needed to resolve each of the DSs These performance requirements include the method detection limits (MDL) and precision and accuracy requirements for each COC

Radionuclides that cannot be determined by analysis because there is no method or the method MDL is not low enough to support decision making may be scaled to measured radionuclides. The radionuclides that are expected to be scaled are C-14, Fe-55, Ni-59, Co-60, Se-79, Mo-93, Zr-93, Nb-94, Pd-107, Cd-113m, Sn-121m, Te-123, Sb-125, I-129, Cs-135, Pm-147, Eu-152, Eu-154, Eu-155, U-232, U-233, Pu-241, Am-242m, Pu-242, and Am-243 The radionuclides listed for scaling are based on estimated MDLs and could change based on actual MDLs reported. See Tables AA-1 and AB-1 for the estimated MDLs and radionuclide upper limit expected concentration in sample The scaling factors will be based on the radionuclide content of N Reactor fuel using ORIGEN II computer code as presented in HNF-6273, Table B-1 When selecting the appropriate scaling factors the behavior of the radionuclide and key radionuclide relative to penetration in the concrete will be considered.

Field measurements of dose may be employed to estimate the radionuclide inventory of a container and provide surveys of the wall and floor as surface removal is being performed. The performance requirements of field instruments are provided in Table A-10

Table A-8 Required Data and Methods and Available Sources References. (2 Pages)

DS #	Required Data	Survey/Sampling/Data Collection Methods	Do Data Exist? (Y/N)	Available Source Reference	Are the Data of Sufficient Quality? (Y/N)	Additional Information Required? (Y/N)
1	Data to determine if the waste is regulated as a listed dangerous waste, in accordance with WAC 173-303-080, -081, and -082.	Process knowledge	Y	Correspondence No 0101943, "Contract No DE-AC06-96RL13200- Completion of Waste Designation for K Basin sludge Waste Streams," letter from P G. Loscoe to D R Sherwood, dated March 27, 2001 WHC-EP-0877, 1995, *K Basin Corrosion Program Report*, Rev 0	Y	N
2	Data to determine if the waste is regulated as a characteristic waste, in accordance with 40 CFR 261 24, 40 CFR 268 40, WAC 173-303-140, and WAC 173-303-090[2]-[8]	Process knowledge	Y	Correspondence No 0101943 F M Lea, 1970, *The Chemistry of Cement and Concrete*, 3rd Ed.	Y	N
3	Data to determine if the waste meets the definition of a toxic dangerous waste, in accordance with WAC 173-303-100 and WAC 173-303-100[5]	Process knowledge, and/or media sampling and analysis	Y	Correspondence No 0101943	Y	N
4	Data to determine if the waste meets the definition of a persistent waste, in accordance with WAC 173-303-100	Process knowledge	Y	Correspondence No 0101943	Y	N
5	Data to determine if the waste is regulated because of PCB concentrations, in accordance with the TSCA or WAC 173-303-9904	Process knowledge	Y	Correspondence No 0101943	Y	N

Table A-8. Required Data and Methods and Available Sources References (2 Pages)

DS #	Required Data	Survey/Sampling/Data Collection Methods	Do Data Exist? (Y/N)	Available Source Reference	Are the Data of Sufficient Quality? (Y/N)	Additional Information Required? (Y/N)
6	Data to determine how the radiological activity of waste compares with the waste acceptance criteria for the candidate facility	Process knowledge, radiological surveys, and/or media sampling and analysis	Y	HNF-6273, 2000, *Data Quality Objectives Process for Designation of K Basin Debris*, Rev 0 HNF-6495, 2001, *Sampling and Analysis Plan for K Basins Debris*, Rev 1 HNF-SD-SNF-TI-015, 2002, *Spent Nuclear Fuel Project Technical Data Book*, Rev 9, Volume 2, "Sludge" UNI-1697, 1981, *KE Fuel Storage Basin Activity Mapping in support of Exposure Reduction* PNNL-14407, 2003, *Underwater Determination of radionuclide Levels in 105-KE Basin Floor and Walls Using a Gamma-Ray Detector System* *Waste Management*, "The Solubility of Actinides in a Cementitious Near-Field Environment," Vol 12, pp 241-252, 1992	N Concentration of radionuclide COCs	Y Concentration of radionuclide COCs
7	Data to determine if the waste is land-disposal restricted, in accordance with 40 CFR 268, "Land Disposal Restrictions"	Process knowledge	Y	Correspondence No. 0101943	Y	N
8	Data to determine if the waste package is compliant for transport under Transportation Safety Document	Process knowledge, and/or media sampling and analysis	Y	HNF-6273 HNF-6495 HNF-SD-SNF-TI-015 UNI-1697 PNNL-14407 Waste Management, "The Solubility of Actinides in a Cementitious Near-Field Environment"	N Concentration of radionuclide COCs	Y Concentration of radionuclide COCs

Table A-9. Analytical Performance Requirements

DS #	COCs	Survey/ Analytical Method	Action Level	MDL	Precision (%)	Accuracy (%)
1	None	None	None			
2	None	None	None			
3	None	None	None			
4	None	None	None			
5	None	None	None			
6	Th-232, Pa-231, U-232, U-233, U-234, U-235, U-236, Np-237, U-238, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Am-242m, Pu-242, Am-243, Cm-242, Cm-243, Cm-244, Sm-151, Eu-152, Eu-154, Eu-155, H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Se-79, Sr-90, Mo-93, Zr-93, Nb-94, Tc-99, Pd-107, Cd-113m, Sn-121m, Te-123, Sb-125, Sn-126, I-129, Cs-134, Cs-135, Cs-137, Pm-147	Analysis of sample and process knowledge See Attachment B for method and MDLs	1 pCi/g each	See Attachment B	50	50 to 150
7	None	None	None			
8	Th-232, Pa-231, U-232, U-233, U-234, U-235, U-236, Np-237, U-238, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Am-242m, Pu-242, Am-243, Cm-242, Cm-243, Cm-244, Sm-151, Eu-152, Eu-154, Eu-155, H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Se-79, Sr-90, Mo-93, Zr-93, Nb-94, Tc-99, Pd-107, Cd-113m, Te, 123, Sn-121m, Sb-125, Sn-126, I-129, Cs-134, Cs-135, Cs-137, Pm-147	Analysis of sample and process knowledge See Attachment B for method and MDLs	2 nCi/g total	See Attachment B	50	50 to 150

COC = Contaminant of concern
DS = Decision statement
MDL = Method detection limit

Table A-10. Field Instrument Performance Requirements

Analyte	Analytical Method	Action Level/ Detection Limit	Accuracy Requirement	Precision Requirement
Dose rate	Portable NaI detector, Bicron, microrem meter or ion chamber	0 1mR/h	[a]	[a]
	Ludlum 133-7 radiation detector	200 mrem/h	[a]	[a]

[a]In accordance with manufacturer specifications.

A3.0 SAMPLE DESIGN

A non-statistical sample collection will be performed as the safety basis limits the location samples may be collected to interior walls. An approximately 9.3 square meters (100 square feet) (SNF-9853, *Data Quality Objectives for K Basin Wall Characterization*) section of wall has been selected to demonstrate the surface removal technology, Figure A-2 is an overview of the K East Basin. Figure A-3 shows the location of the demonstration area in the K East Basin. A sample will be collected from the demonstration area where a higher dose location is identified. In the full-scale operation, real-time dose measurement will be provided by an instrument mounted on the hydrolase head. The dose data will be correlated to sample data, establishing a dose-to-curie relationship that will be applied to the wall and floor or, alternatively, to a waste container. A sample of the surface dose is measured as the surface is removed so a statistical approach for the collection of dose samples is not necessary.

The demonstration of the hydrolase equipment removal of concrete surface on the basin wall will be performed to identify the depth of concrete surface removal required, establish the relationship between the hydrolasing equipment operating parameters and depth of removal, and establish a relationship between the dose measured on the hydrolase head and the activity inventory of the residue (SNF-9853).

Figure A-2. Overview Schematic of the K East Basin.

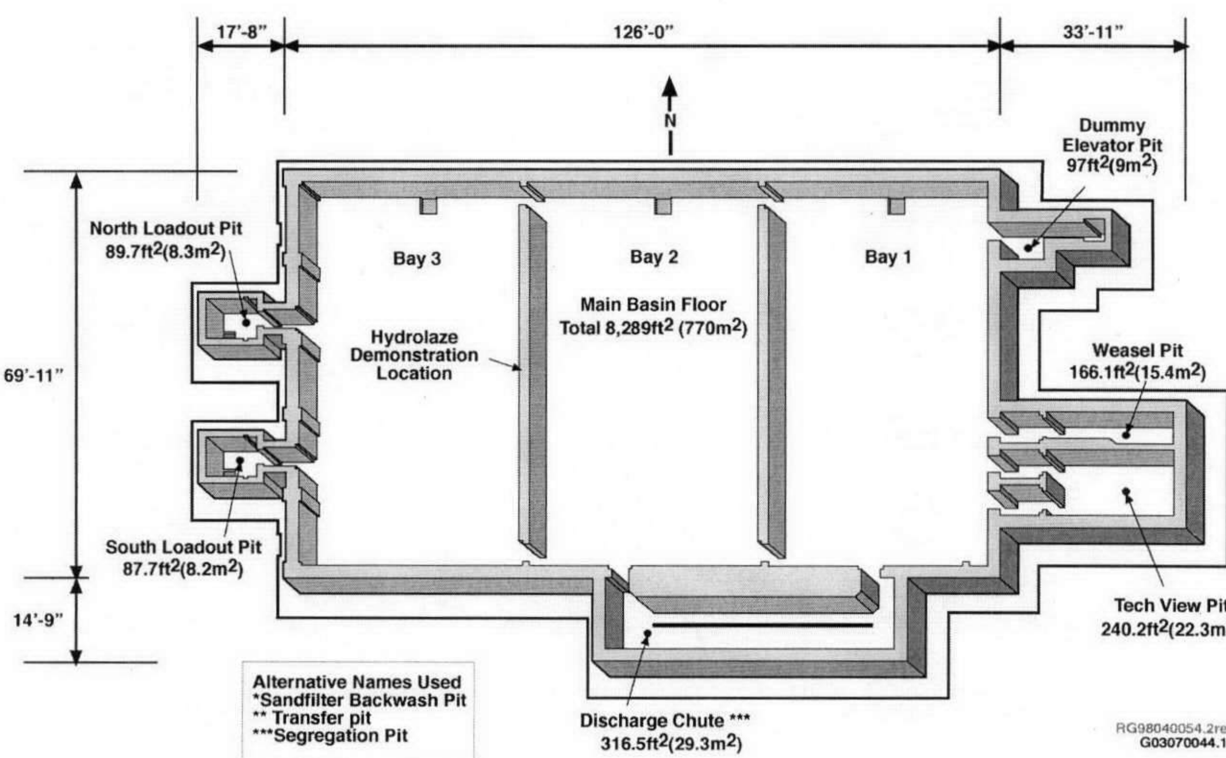
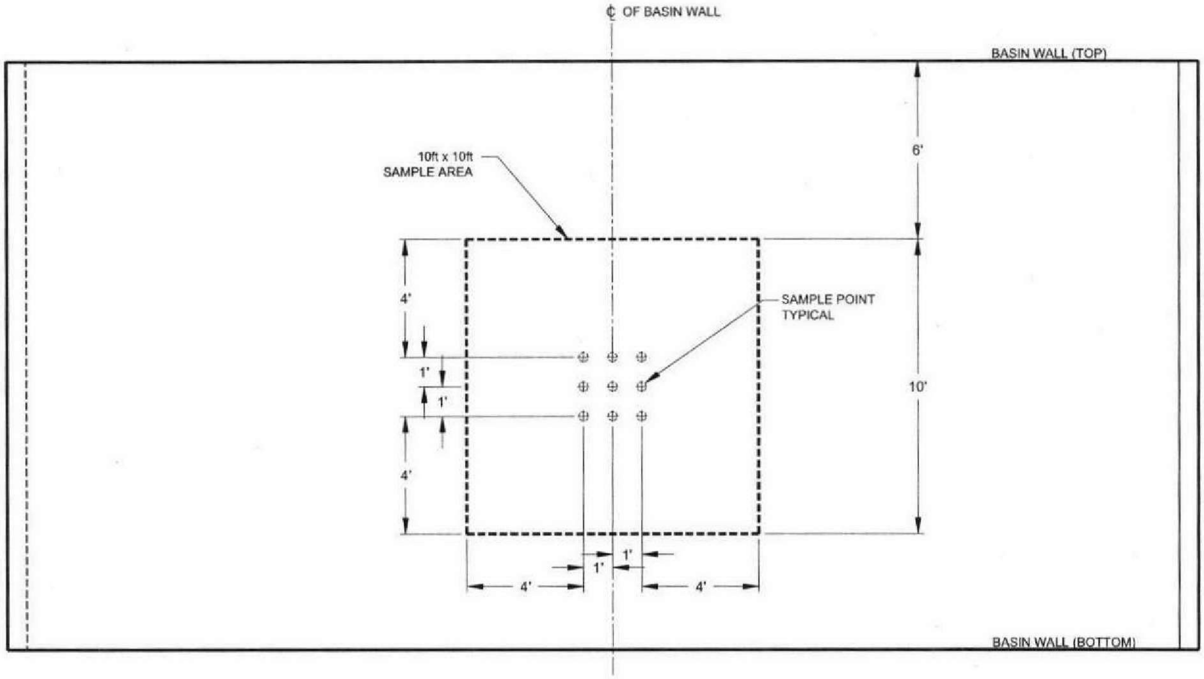


Figure A-3. Locations of Radiation Dose Measurement Points and Hydrolasing Area.



Samples for analysis will be collected at a chosen point in each pass of the demonstration run. Four passes are planned to ensure sufficient Cs-137 removal to meet dose-reduction criteria. It is expected that most radionuclides including actinide elements will be captured on the first pass because they do not have the water solubility or affinity for concrete that Cs-137 does ("The Solubility of Actinides in a Cementitious Near-Field Environment," and UNI-1697, *KE Fuel Storage Basin Activity Mapping in Support of Exposure Reduction*). The sample is collected by diverting the waste slurry to a sample collection filtration system. The sample collection will be at the same point of the wall for each pass. Collection of one sample at one point per pass is limited by the capability of the sample collection equipment. The samples submitted for analysis will consist of cement residue loaded on a filter; it will not include rock material loaded on a strainer. A proof-of-concept demonstration at the vendor facility showed that rock is caught on the strainer and the cement residue passes through the strainer and is collected on a filter. The amount of cement residue versus rock on strainer will be determined by the on site demonstration to support the estimate of the mass of waste collected in a container.

Samples collected at one point on the wall will adequately represent the whole of the wall and floor for the purpose of estimating the radionuclide inventory in a waste container. This is a reasonable premise for the following reasons.

- The contaminant transport mechanism is the same for the wall and floor, that is transport through water into the concrete surface. The water is homogenous being circulated through the basin.

- Measurement of the gamma-emitting radionuclides embedded in the wall and floor demonstrated that walls and floor showed the same magnitude of penetration, except for spots under open-grate-bottom fuel storage locations. Specific floor locations under fuel stored on open-bottom grates show markedly greater gamma-emitting radionuclides, but these locations constitute less than 1 percent of the total surface area.

- The estimate of inventory will employ ratios determined by analysis rather than concentrations, ratios are not sensitive to magnitude variation over the basin surface

In general the doses of wall and floor are about the same except for under locations where fuel was stored on open-bottom grates. In those locations the dose is about a factor of 10 greater The high loading is from local concentration gradients created by deteriorating fuel material laying on the floor. The rest of the floor and wall are exposed to the bulk basin water concentrations, which accounts for the uniformity of surface dose and radionuclide loading

The material and radionuclide inventory for each container of waste will be estimated based on the following

- Depth and area of surface removed (hydrolase operational parameters)
- Measurements of dose on the surface being removed or on the exterior of the waste container
- Analysis and process knowledge of radionuclides and chemical constituents.

The amount of residue in a container is estimated by the depth and surface area removed or by weighing the container. The depth of removal is controlled by setting hydrolase system operation parameters The hydrolasing unit will have a dose measurement device mounted on the head that will measure a portion of the surface dose before and after removal. The difference in dose averaged over the entire surface that is collected in a container will be used to determine the container activity inventory or a dose-to-curie curve will be developed for the concrete surface and/or waste container. All other radionuclides will determined using the concentration ratio to Cs-137 determined by analysis and process knowledge with the amount of removed concrete to determine an inventory. The PCB content of the waste is worst case estimated to be the maximum sludge concentration. If sludge is present, the radionuclide and chemical inventory will be the sum of the concrete and sludge inventory in the container. It is assumed that the filter cake will exhibit free liquid as determined by a paint filter test

A4.0 REFERENCES

40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*, as amended.

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations*, as amended.

40 CFR 761, 1992, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *Code of Federal Regulations*, as amended.

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ATTACHMENT A

ESTIMATE OF CONCENTRATION OF RADIONUCLIDES IN FILTER CAKE

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ATTACHMENT A

ESTIMATE OF CONCENTRATION OF RADIONUCLIDES IN FILTER CAKE

This attachment is an estimate of the radionuclide content of sample material collected for analysis. The content of Cs-137 and Co-60 was estimated based on assays performed on the floor and wall. The remaining radionuclides were determined by scaling to Cs-137 using ratios from HNF-6495, *Sampling and Analysis Plan for K Basins Debris,* and, if the ratios are not in HNF-6495, then in accordance with HNF-6273, *Data Quality Objectives Process for Designation of K Basin Debris* The calculation results, detail and basis are provided in the following paragraphs.

Estimate Concentration of Cs-137 and Co-60 in Sample

Basis

- The wall analysis maximum value reported in PNNL-14407, *Underwater Determination of Radionuclide Levels in 105-KE Basin Floor and Walls Using a Gamma-Ray Detector System,* Table 3 3, at location "wall adjacent to where cubicles 2213 and 2214 meet "
- The minimum scraped depth will be 7millimeters (0 25 inches) to obtain sample
- Sample is 60 percent concrete and 40 percent water.
- Nominal particle density of concrete is 1 92 g/cc (120 pounds per cubic foot)
- 100 square centimeters (cm^2) of wall surface.

Table Attach-A-1 presents calculations estimating the Cs-137 and Co-60 content of sample filter cake.

Table Attach-A-1 Estimate of Cs-137 and Co-60 Content of Sample Filter Cake

Nuclide	Wall Loading ($\mu Ci/cm^2$)	Area (cm^2)	Inventory (Ci)	Volume Concrete (cm^3)	Mass Concrete (g)	Mass Filter Cake (g)	Filter Cake Conc. (Ci/g)
Cs-137	368	100	3 68E-02	70	134 4	224	1 64E-04
Co-60	0 08	100	8 00E-06	70	134 4	224	3 57E-08

volume = 0 7cm x 100 cm^2

Cake density (g/cc)= 1 g/cc x 4 cc + 1 92 g/cc x 0 6 cc = 1 552 g/cc

Estimate of All Radionuclides in Sample

Table Attach-A-2 provides estimates of all radionuclides in the sample cake and decisions on if the radionuclide can be excluded

Table Attach-A-2 Estimate of Radionuclide Concentrations in Filter Cake.

COPC Nuclide List	Debris COC HNF-6495 Nuclide Ratio to Cs-137 (Unitless)	COPC HNF-6273 Nuclide Ratio to Cs-137 (Unitless)	Estimated Conc. in Filter Cake (Ci/g)	Decision
H-3	2 60E-03		4 27E-07	Retain- >1pCi/g
Be-10		3 65E-11	6 00E-15	Remove-<1pCi/g
C-14		1 46E-09	2 40E-13	Retain- mobile nuclide
Fe-55		8 77E-04	1 44E-07	Retain- >1pCi/g
Ni-59		2 35E-04	3 86E-08	Retain- >1pCi/g
Co-60	5 30E-03		3 57E-08	Retain- >1pCi/g
Ni-63	3 60E-04		5 91E-08	Retain- >1pCi/g
Se-79		5 45E-06	8 95E-10	Retain- >1pCi/g
Sr-90	1 05E+00		1 73E-04	Retain- >1pCi/g
Mo-93		3 60E-05	5 91E-09	Retain- >1pCi/g
Zr-93		4 94E-05	8 12E-09	Retain- >1pCi/g
Nb-94		7 87E-08	1 29E-11	Retain- >1pCi/g
Tc-99		3 36E-04	5 52E-08	Retain- >1pCi/g
Pd-107		5.94E-07	9 76E-11	Retain- >1pCi/g
Cd-113m		3 59E-04	5 90E-08	Retain- >1pCi/g
Sn-121m		1 20E-06	1 97E-10	Retain- >1pCi/g
Te-123		4 9E-8	8 05E-12	Retain- >1pCi/g
Sb-125	4 00E-04		6 57E-08	Retain- >1pCi/g
Sn-126		8 20E-06	1 35E-09	Retain- >1pCi/g
I-129		5 20E-07	8.54E-11	Retain- >1pCi/g
Cs-134		1 80E-02	2 96E-06	Retain- >1pCi/g
Cs-135		9 20E-06	1 51E-09	Retain- >1pCi/g
Cs-137	1 00E+00		1 64E-04	Retain- >1pCi/g
Pm-147	2.30E-02		3 78E-06	Retain- >1pCi/g
Sm-147		3 31E-12	5 44E-16	Remove-<1pCi/g
Eu-150		2 30E-11	3 78E-15	Remove-<1pCi/g
Sm-151	1 40E-02		2 30E-06	Retain- >1pCi/g
Eu-152	6 20E-04		1 02E-07	Retain- >1pCi/g
Gd-152		1 70E-18	2 79E-22	Remove-<1pCi/g
Eu-154	1 40E-02		2 30E-06	Retain- >1pCi/g
Eu-155	4 50E-03		7 39E-07	Retain- >1pCi/g

Table Attach-A-2. Estimate of Radionuclide Concentrations in Filter Cake

COPC Nuclide List	Debris COC HNF-6495 Nuclide Ratio to Cs-137 (Unitless)	COPC HNF-6273 Nuclide Ratio to Cs-137 (Unitless)	Estimated Conc. in Filter Cake (Ci/g)	Decision
Pb-210		4.80E-18	7.89E-22	Remove-<1pCi/g
Ra-226		5.30E-13	8.71E-17	Remove-<1pCi/g
Ac-227		1.90E-09	3.12E-13	Remove-<1pCi/g
Ra-228		1.70E-15	2.79E-19	Remove-<1pCi/g
Th-229		9.80E-13	1.61E-16	Remove-<1pCi/g
Th-230		5.90E-11	9.69E-15	Remove-<1pCi/g
Th-232		1.30E-07	2.14E-11	Retain- >1pCi/g
Pa-231		2.10E-07	3.45E-11	Retain- >1pCi/g
U-232		1.30E-08	2.14E-12	Retain- mobile nuclide
U-233		4.70E-10	7.72E-14	Retain- mobile nuclide
U-234	7.40E-05		1.22E-08	Retain- >1pCi/g
U-235	3.00E-06		4.93E-10	Retain- >1pCi/g
U-236		8.20E-06	1.35E-09	Retain- >1pCi/g
Np-237		2.40E-06	3.94E-10	Retain- >1pCi/g
U-238	6.10E-05		1.00E-08	Retain- >1pCi/g
Pu-238	1.70E-02		2.79E-06	Retain- >1pCi/g
Pu-239	7.00E-02		1.15E-05	Retain- >1pCi/g
Pu-240	5.10E-02		8.38E-06	Retain- >1pCi/g
Pu-241	1.74E+00		2.86E-04	Retain- >1pCi/g
Am-241	1.10E-01		1.81E-05	Retain- >1pCi/g
Am-242m		4.00E-07	6.57E-11	Retain- >1pCi/g
Pu-242		2.70E-07	4.44E-11	Retain- >1pCi/g
Am-243		9.80E-08	1.61E-11	Retain- >1pCi/g
Cm-242		3.10E-04	5.09E-08	Retain- >1pCi/g
Cm-243		7.10E-04	1.17E-07	Retain- >1pCi/g
Cm-244	1.30E-04		2.14E-08	Retain- >1pCi/g
Pu-244		1.50E-15	2.46E-19	Remove-<1pCi/g
Cm-245		6.10E-11	1.00E-14	Remove-<1pCi/g
Cm-246		5.50E-13	9.04E-17	Remove-<1pCi/g
Cm-247		7.20E-20	1.18E-23	Remove-<1pCi/g
Cm-248		7.60E-21	1.25E-24	Remove-<1pCi/g

Table Attach-A-2 Estimate of Radionuclide Concentrations in Filter Cake.

COPC Nuclide List	Debris COC HNF-6495 Nuclide Ratio to Cs-137 (Unitless)	COPC HNF-6273 Nuclide Ratio to Cs-137 (Unitless)	Estimated Conc. in Filter Cake (Ci/g)	Decision

Notes

Unwashed KE below-water-Cs-137 ratios in accordance with Table 2-6 of HNF-6495

Maximum ratio to Cs-137 from Table B-1 of HNF-6273 that is not on Table 2-6 of HNF-6495

Nuclides removed from consideration because of a <2-year half life Cr-51, Mn-54, Sr-89, Ru-106, Ag-110m, Sn-119m, Te-125m Sb-126, Sb-126m, Ba-140, Ce-144, Th-231, Th-234, Pa-234m, and Pa-234

Kr-85 removed from consideration as it is a gaseous state

Ba-133 removed as not estimated as being in spent fuel

HNF-6273, 2000, *Data Quality Objectives Process for Designation of K Basin Debris*, Rev 0, Fluor Hanford, Inc , Richland, Washington

HNF-6495, 2001, *Sampling and Analysis Plan for K Basins Debris*, Rev 1, Fluor Hanford, Inc , Richland, Washington

COC = Contaminant of concern

COPC = Contaminant of potential concern

References

HNF-6273, 2000, *Data Quality Objectives Process for Designation of K Basin Debris*, Rev. 0, Fluor Hanford, Inc , Richland, Washington

HNF-6495, 2001, *Sampling and Analysis Plan for K Basins Debris*, Rev 1, Fluor Hanford, Inc., Richland, Washington

ATTACHMENT B

ANALYTICAL METHOD AND METHOD DETECTION LIMITS

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ATTACHMENT B

ANALYTICAL METHOD AND METHOD DETECTION LIMITS

Table Attach-B-1 presents laboratory analytical detection limits for radionuclides The methods stated in the table are procedures of the 222-S Laboratory, procedures from other laboratories that are equivalent also may be used

Table Attach-B-1 Analytical Methods and Detection Limits.

COC Nuclide List	Estimated MDLs		Method Number(s)	Method Description
	Ci/g	µCi/g		
H-3	4 60E-10	4 60E-04	LA-504-101/LA-218-114	Distillation/ LSC
C-14	4 00E-10	4 00E-04	LA-504-101/LA-348-104	Oxidation to CO_2 with LSC
Fe-55			No method	
Ni-59	4 78E-10	4 78E-04	No method	
Co-60	1 25E-07	1 25E-01	LA-549-141/LA-548-121	KOH fusion with GEA
Ni-63	5 00E-09	5 00E-03	LA-549-141/LA-285-102	KOH fusion, separation, LSC
Se-79	1 00E-09	1 00E-03	LA-505-163/LA-365-132	Acid digest, separation, LSC
Sr-90	1 65E-09	1 65E-03	LA-549-141/LA-220-101	KOH fusion, separation, beta counting
Mo-93			No method	
Zr-93			No Method	
Nb-94	1 20E-07	1 20E-01	LA-549-141/LA-548-121	KOH fusion with GEA
Tc-99	3 40E-11	3 40E-05	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Pd-107			No Method	
Cd-113m			No Method	
Sn-121m			No Method	
Te-123			No Method*	
Sb-125	5 50E-06	5 50E+00	LA-549-141/LA-548-121	KOH fusion with GEA
Sn-126	1 14E-11	1 14E-05	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
I-129	2 00E-08	2.00E-02	LA-549-142/LA-378-103	KOH/water digest, separation, LEPS, GEA
Cs-134	1 00E-06	1 00E+00	LA-549-141/LA-548-121	KOH fusion with GEA
Cs-135	3 45E-12	3 45E-06	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Cs-137	1 25E-08	1 25E-02	LA-549-141/LA-548-121	KOH fusion with GEA
Pm-147			No Method	
Sm-151	1 05E-08	1 05E-02	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Eu-152	3 25E-06	3 25E+00	LA-549-141/LA-548-121	KOH fusion with GEA
Eu-154	2 30E-06	2 30E+00	LA-549-141/LA-548-121	KOH fusion with GEA
Eu-155	4 05E-06	4.05E+00	LA-549-141/LA-548-121	KOH fusion with GEA
Th-232	4 40E-17	4 40E-11	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Pa-231	4 72E-13	4.72E-07	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
U-232	3 85E-10	3 85E-04	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
U-233	1 74E-13	1 74E-07	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis

Table Attach-B-1. Analytical Methods and Detection Limits.

COC Nuclide List	Estimated MDLs Ci/g	µCi/g	Method Number(s)	Method Description
U-234	3.75E-14	3 75E-08	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
U-235	4 32E-17	4 32E-11	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
U-236	5 18E-16	5 18E-10	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Np-237	3 81E-14	3.81E-08	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
U-238	4 37E-16	4 37E-10	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Pu-238	1 70E-09	1 70E-03	LA-549-141/LA-953-104	KOH fusion, separation, AEA
Pu-239	7 44E-12	7 44E-06	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Pu-240	2 27E-12	2 27E-06	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Pu-239/240	1 70E-09	1 70E-03	LA-549-141/LA-953-104	KOH fusion, separation, AEA
Pu-241			No method	
AMU-241(Pu)	1 65E-08	1 65E-02	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Am-241	5 50E-09	5 50E-03	LA-549-141/LA-953-104	KOH fusion, separation, AEA
Am-242m			No method	
Pu-242			No method	
AMU-242(Am)	8.38E-11	8 38E-05	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
AMU-242(Pu)	3 16E-14	3 16E-08	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
AMU-242(Cm)	2 65E-08	2 65E-02	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Cm-242	5 50E-09	5 50E-03	LA-549-141/LA-953-104	KOH fusion, separation, AEA
Am-243			No method	
AMU-243(Am)	2 00E-12	2 00E-06	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
AMU-243(Cm)	5 06E-10	5 06E-04	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
AMU-244(Cm)	8 10E-10	8 10E-04	LA-505-163/LA-506-101	Acid digest, ICP/MS analysis
Cm-243/244	5 50E-09	5 50E-03	LA-549-141/LA-953-104	KOH fusion, separation, AEA

*Interference with naturally occurring antimony renders method unreliable

AEA = Alpha energy analysis
GEA = Gamma energy analysis
ICP = Inductively coupled plasma
LEPS = Low-energy photon system
LSC = Liquid Scintillation Counting
MS = Mass spectrometry

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